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A REPORT OF WATER POLLUTION IN THE SOUTH PLATTE RIVER BASIN

Public Health Service
Kansas City, Missouri

February 1953

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Water Pollution Series No. 39

For Clean Water–"One River, One Plan."

SOUTH PLATTE RIVER DRAINAGE BASIN

A COOPERATIVE STATE-FEDERAL REPORT ON WATER POLLUTION

FEBRUARY 1953

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COLORADO
Department Of Public Health

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Department Of Public Health

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Department Of Health

FEDERAL SECURITY AGENCY
Public Health Service

A REPORT OF WATER POLLUTION

IN THE

SOUTH PLATTE RIVER BASIN

Prepared by

COLORADO DEPARTMENT OF PUBLIC HEALTH
Division of Sanitation

NEBRASKA DEPARTMENT OF HEALTH
Division of Sanitation

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PUBLIC HEALTH SERVICE
Division of Water Pollution Control
Missouri Drainage Basin Office

Federal Security Agency
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SOUTH PLATTE RIVER BASIN

WATER POLLUTION REPORT

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INTRODUCTION

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June 1948, requires the Surgeon General of the Public Health Service to cooperate with other Federal agencies, with State and interstate water pollution control agencies, and with municipalities and industries in the preparation or adoption of comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof, and improving the sanitary condition of surface and underground waters. Due regard must also be given to improvements necessary to conserve the waters for public and industrial water supplies, propagation of fish and aquatic life, recreational purposes, agricultural and other legitimate uses.

This report is produced under the cosponsorship of the Colorado Department of Public Health, the Nebraska Department of Health, and the Wyoming Department of Public Health, and the U. S. Public Health Service. It is based on data gathered and reported in the South Platte River Basin Water Pollution Investigation Report of 1950[1] and subsequent information. The report also presents information concerning use of water resources, pollution entering water resources and resulting damages, benefits which may result from pollution prevention and abatement, pollution prevention measures in effect and those needed.

Data and knowledge now available are sufficient to permit the immediate solution of most of the pollution problems within the South Platte River Basin without awaiting the results of additional surveys and studies.

A sincere effort has been made to present a fair picture of the water pollution problems in the South Platte River Basin and to present reasonable conclusions and recommendations. It is our hope that this report, as a step in the cooperative development of an ultimate comprehensive water pollution control program will help in safeguarding the water resources.

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[1]The technical report of 1950 is available upon request.

ACKNOWLEDGMENTS

Acknowledgment is made of the invaluable assistance furnished by the water pollution control agencies of Colorado, Nebraska and Wyoming, and the City and County of Denver, Colorado, in supplying and reviewing data pertinent to the report.

Acknowledgment is also made of the use of data from the 1950 Report of the South Platte River Basin Water Pollution Investigation Report and to the cooperating agencies responsible for its publication. Much information was also gained from the published reports of the Corps of Engineers, Department of Defense; the Bureau of the Census, Department of Commerce; the Fish and Wildlife Service, the Geological Survey, the Bureau of Reclamation, and the National Park Service, Department of Interior.

Finally, there is acknowledged the assistance of industrial and municipal officials and individuals interested in water resources development and conservation who have contributed information.

Thanks is tendered to the following reviewing agencies whose comments have materially improved the report: Bureau of Reclamation, Region VII, Denver, Colorado; Corps of Engineers, Missouri River Division, Omaha, Nebraska; National Park Service, Omaha, Nebraska; Fish and Wildlife Service, Billings, Montana; Department of Agriculture, Lincoln, Nebraska; Department of Commerce, Denver, Colorado; Environmental Health Center, Cincinnati, Ohio, and the Division of Water Pollution Control, Public Health Service, Washington, D. C.

Special recognition is made of the interest and cooperative effort displayed by the Great Western Sugar Company in initiating research and demonstration projects aimed at reducing wastes from sugar beet refining operations.

SUMMARY

The South Platte River Basin encompasses 24,030 square miles, of which 19,022 are in Colorado, 3,011 in Nebraska, and 1,997 in Wyoming. The South Platte River rises along the eastern front range of the Rocky Mountains in central Colorado and flows northeasterly some 440 miles to join the North Platte River at North Platte, Nebraska. All but about 60 miles of the main stem is within the State of Colorado. The South Platte River is a shallow, swiftly flowing, relatively small stream. It has a mean annual discharge of 500 second-feet; however, periods of no flow exist during maximum water use or drought.

The Basin climate, generally semiarid, is largely influenced by topographic characteristics. The greatest precipitation occurs in the mountains. Approximately one-fourth of the region lies above 8,000 feet mean sea level; one-fourth is between 6,000 and 8,000 feet m.s.l.; and the remainder between 3,000 and 6,000 feet m.s.l.

In 1950 the population of the Basin was 840,000, of which 90 percent lived in Colorado, 5 percent in Nebraska, and 5 percent in Wyoming. Approximately 70 percent of the population is classified as urban. Denver, Colorado, the largest city, had a 1950 population of 415,786.

The economy of the Basin is supported by agriculture, a large resort and tourist business, and a variety of industries. Most crops are raised on irrigated land and include hay, forage, sugar beets, potatoes, barley, beans, corn, oats, rye, sorghums and wheat. Large numbers of livestock are produced. Truck farming, particularly in the vicinity of Denver, is important. Much of the industry of the Basin is closely allied with agriculture. Large quantities of sugar beets, fruits, vegetables, milk, meat, poultry and grains are processed.

Mining is an extensive operation, ranking third in value of production. Coal, gold, silver, copper, lead and zinc are mined in considerable amounts. Coal has become the most valuable product of the mining industry in recent years. Oil production has been a very valuable industry. Recent discoveries of oil in the vicinity of Sterling, Colorado, and Sidney, Nebraska, have resulted in a rapid growth of the industry in northeastern Colorado and southwestern Nebraska.

Water use continues to be a major factor in the Basin development and, unless more efficient use is made of existing water resources or additional water is secured, further economic expansion will come slowly. Water resources have been overappropriated and it is seldom that all water rights can be met. Two transmountain diversions - the proposed Blue-South Platte and the Colorado-Big Thompson now essentially completed - will add approximately 690,000 acre-feet annually to the Basin's water supply.

The major water uses are irrigation, water supplies for 28 communities including Denver, industrial operations, hydroelectric power, stock watering and recreation. Municipal and industrial requirements exceed 258,000 acre-feet annually although most of this water is

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returned to the waterways. Water plays a very important role in recreational potentialities of the Basin. The beautiful mountain streams are very important adjuncts to the mountain scenery and provide excellent fishing. Catering to the tourist trade has become one of the region's most important businesses. The watering of livestock is a significant use. Basin waters are used extensively for production of hydroelectric power.

Streams of the Basin carry great quantities of waste from population centers and numerous industrial establishments. This salient function has been carried to such an extreme that other water uses have been seriously jeopardized. The health and welfare of the public in urban centers and rural areas is continuously endangered due to the use of sewage-polluted waters of the South Platte River. Seventy-three communities discharge sewage and industrial wastes totaling an estimated 480,070 population equivalents to streams of the South Platte system. Fifty-two industrial plants with separate outlets discharge wastes having a seasonal population equivalent of 4,198,410. In addition, 36 industries contribute to waterways inorganic materials such as silt, rock flour, acids, alkalies and metallic ions. Interstate pollution occurs below Ovid, Colorado.

The use of sewage and waste-laden waters for irrigation of truck gardens and other farm crops has been noted by public health authorities[1]. The irrigation of low growing fruits and vegetables, especially those commonly consumed without cooking, is of particular significance. Studies already accomplished indicate that vegetables irrigated with polluted waters carry greater concentrations of bacteria of the intestinal groups than do vegetables irrigated with nonpolluted waters. Transmission, by this means, of enteric parasites such as tapeworms is well recognized particularly in cattle pastured on lands irrigated with contaminated water.

Nuisance conditions often exist below the discharge of significant municipal and industrial wastes. In the Denver area nuisances occur in the Burlington-O'Brian Ditch, Sand Creek, and the South Platte River. Decomposing sludge banks produce bad odors and unsightly conditions at other localities. According to historical records, Clear Creek was an excellent fishing stream prior to extensive mining developments in the watershed. Elsewhere, fish and other aquatic life have been driven from sections of streams that have become highly polluted. It is probable, however, that the lower reaches of certain streams under present conditions of flow regulation and water use would not form suitable fish habitat since, during portions of the year, discharges are extremely low or nonexistent. Industrial water supplies taken from the polluted streams are of poor quality, their usage usually being limited to cooling and, in many instances, the build-up of slimes has seriously curtailed even this use. Polluted streams have limited recreational value.

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[1]Colorado Medicine, January 1934, Dr. E. W. Chapman, Rep't. Colorado Municipalities Jan.-Feb. 1934.

Benefits attributable to pollution control and abatement are directly related to water uses of the Basin. Installation of sewage treatment facilities at many of the municipalities has reduced nuisance conditions, produced local beneficial results to irrigators, industrial water users, and has generally improved the public health and welfare. It is axiomatic that when man is surrounded by a proper environment he tends toward a longer and more productive life.

Municipalities of the South Platte Basin have made considerable effort toward control of their wastes. Twenty-nine sanitation districts have been formed in the Denver area for collection and disposal of wastes. Fifteen of the districts have contractual agreements with the City of Denver for waste disposal through its treatment plant. The remaining groups have treatment plants or are planning for sewage collection and disposal. Wastes from 31 municipalities are treated in 16 primary treatment works and 26 communities treat wastes in 27 secondary treatment plants. However, 16 communities discharge wastes without benefit of any type of treatment. About one-half of the industrial establishments discharging directly to streams provide some treatment for wastes. The beet sugar refining industry is studying its waste problem and has inaugurated a program of recovery and treatment. About 180 industries connected to municipal sewers have wastes treated in municipal installations.

Legislation controlling pollution has been notably inadequate in two States of the Basin. Colorado, through a committee appointed by the Governor, is now proposing legislation to improve control of pollution in that State, and in Nebraska an attempt is being made to secure stream pollution control legislation. Recently, the statutes of Wyoming were amended to considerably broaden the water pollution control agency's enforcement powers. The Engineering Section of the Missouri Basin Health Council, consisting of the Chief Sanitary Engineers of the 10 Missouri Basin States, has adopted tentative objectives as a recommended guide for water pollution control programs in the Basin. These objectives recognize that a minimum of primary treatment or its equivalent should be provided at all sources of pollution, additional treatment should be installed where needed, and toxic materials should be virtually eliminated from waste discharges.

There is need for 15 new municipal plants, 27 enlargements or additions, and 2 replacements. These improvements would serve more than 627,210 people. Treatment or other control measures should be effected at 56 major industrial plants with separate outlets; 2 of the existing works should be replaced. Only 14 cities and 22 industries have facilities which are considered adequate at the present time. Table 1 lists the names of municipalities and industries where treatment is needed and the recommended degree of treatment. Disinfection of sewage treatment plant effluents is recommended for control of bacterial pollution to protect downstream water supplies and to reduce possible contamination of food crops during the irrigation period.

Construction costs of the recommended municipal projects are estimated at $7,000,000. Industrial wastes treatment needs are estimated to require approximately $3,500,000. Trunk sewers, pumping stations, chlorination equipment, maintenance and operation costs are not included in these figures.

CONCLUSIONS

1. The water and land resource development program of the Basin will affect stream flow and phases of public health and sanitation dependent upon provisions of adequate stream discharge. The extent of the effect will depend upon flow regulation to result from considerations of public water supplies, hydroelectric power, irrigation, stream sanitation, sediment control, and recreation in the Blue-South Platte and Colorado-Big Thompson Projects.

2. Existing and potential municipal water supplies can benefit by the development program.

3. Twenty-eight communities obtain water supplies from surface sources to serve 633,000 people 137.89 million gallons per day; 49 use ground sources to serve 62,000 people 12.10 million gallons per day.

4. Pollution discharged to surface water resources causes public health hazards and nuisance conditions at several locations. Seventy-three communities and numerous major industrial plants produce domestic and industrial wastes which total seasonally approximately 5,000,000 population equivalents; 4,110,000 population equivalents are discharged by beet sugar factories during fall operations. Existing sewage treatment reduces organic pollution, excluding the beet sugar refinery wastes, about 46 percent.

5. Interstate pollution exists below Ovid, Colorado, and extends into Nebraska.

6. New treatment facilities are needed at 15 communities; 2 need replacements of existing works; and 27 should have existing facilities enlarged (table 1).

7. New treatment works, additions, or replacements are needed at 56 major industries.

8. An active Basin-wide comprehensive program, adequately supported by funds and legislation, is essential for effective control and abatement of pollution.

RECOMMENDATIONS

It is recommended that:

1. A comprehensive program for water pollution control in the South Platte River Basin be formulated by the State water pollution control agencies of Colorado, Nebraska, and Wyoming.

2. The State legislatures of Colorado and Nebraska enact comprehensive water pollution control legislation, and that all Basin States support their water pollution control agencies with adequate funds to permit effective operation.

3. Sewage and industrial waste treatment as recommended in table 1 be provided by the appropriate municipality or industry. Toxic materials should be virtually eliminated from waste discharges.

4. Construction and operating agencies cooperating in development of water and land resources of the South Platte River Basin consider the sanitation, public health and welfare functions of streams in addition to other legitimate water uses.

5. Public water supplies secured from surface waters, those from shallow ground sources, and all supplies showing coliform contamination in excess of acceptable drinking water standards, be chlorinated in addition to other necessary treatment.

6. Caution be exercised in the use of sewage-polluted waters for irrigating low growing vegetable and root crops which may be consumed raw. Effective chlorination of sewage treatment plant effluents to control pathogenic organisms is recommended.

7. Consideration be given to methods for reducing silt and related pollution which affects water treatment plant operation and maintenance, destroys fisheries, and reduces other recreational uses.

8. Training of waste treatment plant operators be intensified to insure efficient utilization of treatment works.

Table 1. South Platte River Basin - Project list - Municipalities and industries needing improvements for abatement of pollution

Name	Population served		Project needs[1]	
Colorado				
Arvada (S.D. #1)	2,400		Addition[2]	(Secondary)
Aurora (S.D. #27)	17,000		Replace[2]	(Secondary)
Baker (S.D. #22)	2,000		Addition	(Secondary)
Berthoud	1,060		Addition[3]	(Secondary)
Boulder	21,400		Enlarge and addition	(Secondary)
Brighton (S.D. #24)	4,500		Addition[3]	(Secondary)
G-W Sugar Refinery		180,000[4]	Addition	(Secondary)
Kuner-Empson Cannery		7,500[4]	New plant	(Secondary)
Brush	2,500		Addition	(Secondary)
G-W Sugar Refinery		250,000[4]	New plant	(Secondary)
Buckley Field	1,900		Addition[3]	(4)
Bureau of Reclamation Camp	500		Addition[3]	(Secondary)
Castle Rock	740		Replace	(Secondary)
Central City	200		New plant	(Secondary)
Clear Creek (S.D. #2)	2,000		New plant[2]	(Secondary)
Dacono				
McNeil Coal Co.		-	New plant	(Adequate control measures)
Sterling Mine				
Shamrock Coal Co.				(Adequate control measures)
Shamrock Mine		-	New plant	
Deer Trail	380		New plant	(Secondary)
Denver	432,700		Addition[2]	(Secondary)
East Denver Plant	25,000		Addition	(Secondary
Near Denver				
Altberger Packing Co.		1,860[4]	New plant	(Secondary)
Bay Petroleum Co.		2,400[4]	Additions	(Secondary)
Brookridge Farms Dairy		920[4]	New plant	(Secondary)
Capitol Rendering Co.		750[4]	New plant	(Secondary)
Central Fibres Products Co.		7,750[4]	New plant	(Secondary)
City Park Farm Dairy		350[4]	New plant	(Secondary)
C.B. & Q. R.R. Shops		-	New plant	(Primary)
Colorado & Southern R.R. Shops		-	New plant	(Primary)
Continental Oil Co.		4,800[4]	Additions	(Secondary)
Doerfler Horse Packing Co.		740[4]	New plant	(Secondary)
Garden Farms Dairy		750[4]	New plant	(Secondary)
Litvak Meat Co.		3,310[4]	New plant	(Secondary)
National Food Stores, Inc.		4,800[4]	New plant	(Secondary)
Rio Grande R. R. Shops		-	New plant	(Primary)
Sammett Packing Co.		800[4]	New plant	(Secondary)
Santa Fe R. R. Shops		-	New plant	(Primary)
Eaton	1,400		Addition	(Secondary)
G-W Sugar Refinery		140,000[4]	Additions	(Secondary)
Erie				
Clayton Coal Co.				(Adequate control measures)
Lincoln Mine		-	New plant	
Erie Coal Co.				(Adequate control measures)
Erie Strip Mine		-	New plant	
Imperial Coal Co.				(Adequate control measures)
Imperial Mine		-	New plant[5]	
Estes Park	4,000		Addition[3]	(Secondary)
Fairplay				(Adequate control measures)
South Platte Dredging Co.			Replace	
Federal Correctional Institution	500		Addition[3]	(Secondary)
Fort Collins	15,000		Addition	(4)
Dreher Pickle Co.		2,600[4]	New plant	(Secondary)
G-W Sugar Refinery		710,000[4]	Additions	(Secondary)
Fort Lupton	2,200		Addition	(Secondary)
Fort Morgan				
Tieman Packing Co.		600[4]	Additions	(Secondary)
G-W Sugar Refinery		480,000[4]	Additions	(Secondary)
M & B Packing Co.		450[4]	Additions	(Secondary)
Colorado (cont'd)				
Fruitdale (S.D. #3)	1,000		New plant[2]	(Secondary)
Georgetown	120		New plant	(Secondary)
Golden (S.D. #17)	6,200		New plant[6]	(Secondary)
Adolph Coors		12,860[4]	New plant	(Secondary)
Greeley	21,000		Addition	(Secondary)
Associated Seed Growers, Inc.		2,300[4]	New plant	(Secondary)
G-W Sugar Refinery		180,000[4]	Additions	(Secondary)
Greeley Rendering Co.		1,700[4]	Additions	(Secondary)
Idaho Springs	1,800		New plant	(Secondary)
Johnstown	900		New plant	(Secondary)
Julesburg	1,800		New plant	(Secondary)
H. E. Reichelt, Jr.		-	New plant	(Adequate control measures)
Lafayette	1,280		Addition[3]	(Secondary)
Black Diamond Fuel Co. Mine #2		-	New plant	(Adequate control measures)
Larimer Co.				
Cherry Products Co.		2,600[4]	New plant	(Secondary)
LaSalle	800		Addition	(Secondary)
Farr Farms Potato Co.		-	Addition	(Adequate control measures)
Littleton (S.D. #21)	6,500		Enlarge and addition[3]	(Secondary)
Longmont	8,000		Addition[3]	(Secondary)
G-W Sugar Refinery		700,000[4]	Additions	(Secondary)
Kuner-Empson Cannery		18,000[4]	New plant	(Secondary)
Loretto Heights College	400		Addition	(Secondary)
Loveland	8,000		Two additions[3]	(Secondary)
G-W Sugar Refinery		640,000[4]	Additions	(Secondary)
Kuner-Empson Canning Co.		2,600[4]	New plant	(Secondary)
Lucerne				
Lucerne Potato Growers		-	Additions	(Adequate control measures)
Weld Co. Potato Growers Assn.		-	Additions	(Adequate control measures)
Lyons	1,430		New plant[2]	(Secondary)[7]
Meriam	300		New plant	(Secondary)
Milliken	500		New plant	(Secondary)
Ovid	700		New plant	(Secondary)
G-W Sugar Refinery		290,000[4]	New plant	(Secondary)
Platteville	700		New plant	(Secondary)
Platteville Potato Assn.		-	New plant	(Adequate control measures)
Silver Plume	140		New plant	(Secondary)
Mile High Mining Co.		-	Replace	(Adequate control measures)
Sterling	7,500		Addition	(Secondary)
G-W Sugar Refinery		380,000[4]	New plant	(Secondary)
Sterling Rendering Works		1,280[4]	New plant	(Secondary)
Tollgate (S.D. #29)	260		New plant	(Secondary)
Wellington	640		Addition	(Secondary)
Westminster (S.D. #23)	3,500		Addition[3]	(Secondary)
Wheatridge (S.D. #4)	2,300		Addition	(Secondary)
Windsor	2,000		Addition[3]	(Secondary)
G-W Sugar Refinery		210,000[4]	New plant	(Secondary)
Nebraska				
Chappell	1,200		Addition[2]	(Secondary)
Kimball	2,000		Addition	(4)
Ogallala	2,000		(7)	(4)
U.P.R.R. Water Plant		-	New plant	(Adequate control measures)
Sidney	5,000		Addition	(4)
Star Packing Co.		230[4]	New plant	(Secondary)
U.P.R.R. Water Plant		-	New plant	(Adequate control measures)
Wyoming				
Cheyenne				
S. & S. Packing Co.		320[4]	New plant	(Secondary)
U.P.R.R. Shops		-	New plant	(Adequate control measures)

[1]Disinfection of sewage treatment plant effluents is recommended where it is necessary to protect downstream water uses.
[2]Under construction.
[3]Municipal secondary treatment plants which require secondary sedimentation units.
[4]Disinfection recommended for effluents of five existing secondary treatment plants.
[5]New plant under construction which will treat Coors industrial wastes and municipal wastes from Golden.
[6]Lyons is constructing a new primary plant. Protection of downstream water uses indicates that secondary treatment and efficient effluent disinfection are necessary.
[7]Existing secondary treatment plant requires reactivation.
[8]Organic population equivalent of waste discharged by industry.

GENERAL DESCRIPTION

Historical Background

The South Platte River Basin (Map No. 1), a portion of the Louisiana Purchase, became a part of the United States in 1803. The Spanish explored the region during the 16th and 17th centuries but left only meager records of their findings. In 1806 an expedition under Lt. Zebulon Pike began extensive explorations and discovered the mountain peak which bears his name. Other exploratory expeditions entered the region in rapid succession. As early as 1825 a lucrative fur trade attracted frontiersmen who established trading posts and protective forts. Most famous of these men were the Bent Brothers, Ceran St. Vrain, Louis Vasquez, Kit Carson and Jim Bridger.

In 1858 gold was discovered along the South Platte River at its junction with Cherry Creek. Settlements were established along the river at the present location of Denver, and the region was organized as a portion of the Kansas Territory in that year. In 1859 a major gold strike was made on North Fork of Clear Creek. A rapid succession of gold strikes in the Clear Creek, Boulder Creek, and Denver areas precipitated a gold rush and development of the area progressed rapidly. The gold fever gradually subsided and many miners turned to farming and other means of livelihood. In 1861 the Colorado Territory was created by Congress. The Union Pacific Railroad was constructed along the South Platte River to Julesburg, Colorado, then westward through the Nebraska panhandle to Cheyenne, Wyoming. The first railroad to reach Denver was constructed from Cheyenne in 1870. Development continued at a rapid pace, and in 1876 the Colorado Territory was granted statehood. Much of the history of Colorado is bound up in its efforts to conserve and utilize its waters for irrigation purposes. It was in Colorado that the doctrine of appropriated rights as opposed to riparian use of water was developed.

The South Platte Basin with its scenic wonderland, great reserve of mineral resources, forests and fertile lands has developed tremendously in less than 100 years. Future progress is largely dependent upon the availability of enough water to continue expansion of its agricultural pursuits, supply its domestic population and its industries, and provide for its sanitation needs.

Physical Description

The South Platte River rises in the high, precipitous front range of the Rocky Mountains of Central Colorado. It flows for approximately 440 miles northeasterly to its confluence with the North Platte River near North Platte, Nebraska. The drainage area encompasses 24,030 square miles, of which 19,022 are in Colorado, 3,011 in Nebraska, and 1,997 in Wyoming. Approximately 25 percent of the Basin is over 8,000 feet m.s.l.; 25 percent is at an elevation of 6,000 to 8,000 feet m.s.l.; and 50 percent lies between 3,000 and 6,000 feet m.s.l.

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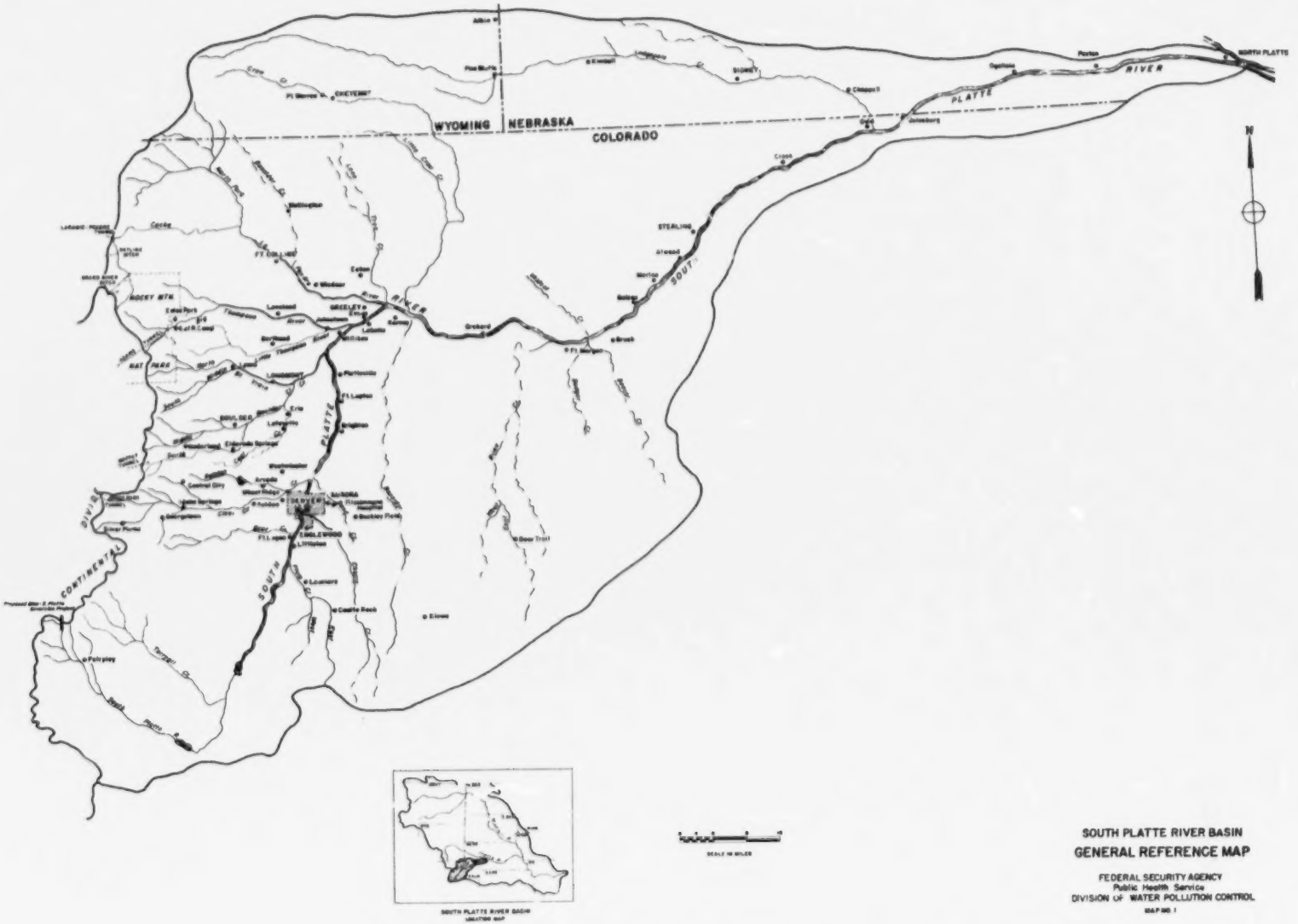

SOUTH PLATTE RIVER BASIN
GENERAL REFERENCE MAP

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

MAP NO. 1

Streams in mountain sections are swift flowing, with slopes varying from 20 feet to 1,000 feet per mile. The average gradient of the South Platte from its mouth to Denver is about 8 feet per mile, and it increases to about 70 feet per mile above Denver. All streams of the South Platte originating in mountains are perennial; those beginning in the high plains are intermittent. Principal tributaries are presented in table 2. The mean annual recorded runoff of the South Platte River at North Platte, Nebraska, is approximately 380,000 acre-feet.

Table 2. South Platte River Basin - Principal tributaries of the South Platte River

Tributary	Length stream (miles)	Drainage Area (square miles)	Source elevation (feet)
Bear Creek	44	265	12,740
Cherry Creek	-	414	7,630
Clear Creek	67	600	12,200
St. Vrain Creek	61	1,000	12,400
Big Thompson River	79	842	11,000
Cache la Poudre River	121	1,840	10,700
Crow Creek	140	1,515	8,600
Lodgepole Creek	216	3,100	8,500

A variety of climatological conditions exists throughout the Basin. Recorded extreme temperatures show highs in excess of 100° F., and lows of about -40° F. The average growing season at Denver is 163 days, at Boulder 165 days, and 145 days at Julesburg. The relative humidity of the region is low, averaging less than 60 percent at Denver. The entire Basin lies within a semiarid region with rainfall averaging about 15 inches. Maximum precipitation occurs in the mountain area and the minimum in the high plateau section. Average rainfall at Hartsel is 11.1 inches, that at Greeley 12.35 inches. Precipitation at Silver Lake in the mountains is 31 inches.

The mountains provide a great deal of mineral wealth, primarily lead, silver, gold, zinc and coal. There has been a recent increase in producing oil wells in the plains section and numerous gas wells exist in the lower valley.

Silt carried by numerous mountain streams has formed rich alluvial plains where those streams emerge from the mountains. Here, intensive agriculture is practiced when sufficient irrigation water is available. The lumber industry has a rich source of material in coniferous forests which cover the mountains. Mountains, forests, and waterways form a scenic wonderland which has resulted in "Colorful Colorado" being called the playground of America.

Economic Development

The 1950 population of the Basin was approximately 840,000. Ninety percent resided in Colorado, about 5 percent in Nebraska, and 5 percent in Wyoming. Approximately 70 percent live in urban areas, that is, in cities of 2,500 people or larger, and the remaining 30 percent in small towns and on farms. The population growth has been steady (table 3); the increment 1940-1950 was about 28 percent of the 1940 census. The principal cities have grown; Denver increased 29 percent since 1940 to 415,786; Boulder, 54 percent to 19,999; Fort Collins, 21 percent to 14,937; Greeley, 27 percent to 20,734; and Cheyenne, Wyoming, 41.5 percent to 31,935. The large and consistent increases reflect the agricultural, commercial, and industrial development of the area.

Agricultural products have steadily increased in volume and value. Hay, wheat, sugar beets, potatoes, beans, corn, oats, rye and barley are the principal crops. A large and thriving livestock industry, together with dairying, is very important to the Basin.

Industrial development is quite diversified. Denver is the center of manufacturing. Principal Basin industries process food and farm products, separate and process mineral ores, or refine petroleum.

An important and growing industry in the Basin is that of catering to tourists and resort operations. While an accurate estimate of its value is not available, it is reported to be about equal to that of agricultural production. The Rocky Mountain National Park, in which the headwaters of the Big Thompson River are located, is a nationally known park area. Many other sections of the Basin also offer scenic and recreational attractions. The proximity of scenic and recreational areas to Denver and the conveniently located transcontinental travel facilities make the resorts available to great numbers of tourists each year.

Five major railroad systems, several airlines, and an excellent system of highways traverse the Basin.

Agricultural development of the Basin is closely allied with available irrigation water. Contemplated transmountain diversions of water from the western slope would increase the Basin's water resources.

Table 3. South Platte River Basin - Population of municipalities

Municipality	Population - U. S. Census 1930	1940	1950
Colorado			
Arvada	1,276	1,482	2,359
Ault	737	761	866
Aurora	2,295	3,437	11,421
Bailey	-	412	337
Berthoud	811	811	867
Big Springs	595	569	527
Black Hawk	253	289	166
Boulder	11,223	12,958	19,999
Brighton	3,394	4,029	4,336
Brush	2,312	2,481	2,431
Bushnell	341	252	225
Castle Rock	478	580	741
Central City	572	706	371
Crook	251	236	259
Dacono	275	296	258
Deer Trail	390	387	421
Denver	287,861	322,412	415,786
Dix	279	199	270
Eaton	1,221	1,322	1,276
Edgewater	-	1,648	2,580
Empire	93	174	228
Englewood	7,980	9,680	16,869
Erie	930	1,019	937
Estes Park	417	994	1,617
Evans	540	792	862
Fairplay	221	739	476
Firestone	240	262	297
Ft. Collins	11,489	12,251	14,937
Ft. Lupton	1,578	1,692	1,907
Ft. Morgan	4,423	4,884	5,315
Frederick	596	652	599
Georgetown	303	391	329
Golden	2,426	3,175	5,238
Greeley	12,203	15,995	20,354
Grover	165	137	146
Henderson	873	942	1,124
Hershey	473	487	573
Hillrose	210	177	190
Hudson	346	295	365
Idaho Springs	1,207	2,112	1,769
Iliff	266	322	235
Johnstown	767	961	897
Julesburg	1,467	1,619	1,951
Keenesburg	277	284	432
Kersey	307	268	304

Table 3. South Platte River Basin - Population of municipalities (cont'd.)

Municipality	Population - U. S. Census 1930	1940	1950
Colorado (cont'd.)			
Kiowa	185	195	173
Lafayette	1,842	2,052	2,090
La Salle	564	755	797
Littleton	2,019	2,244	3,378
Lodgepole	436	479	555
Longmont	6,029	7,406	8,099
Louisville	-	2,023	1,978
Loveland	5,506	6,145	6,773
Lyons	567	654	689
Mead	152	191	186
Merino	230	259	209
Milliken	483	531	510
Morrison	177	216	306
Mountain View	-	711	878
Nederland	285	384	266
Nunn	196	190	182
Orchard	-	865	956
Ovid	649	687	664
Palmer Lake	244	269	263
Parker	403	331	360
Peetz	244	207	232
Pierce	281	343	372
Platteville	533	561	570
Sedgwick	444	373	332
Silver Plume	126	139	136
Sterling	7,195	7,411	7,534
Wellington	533	465	541
Westminster	436	534	1,686
Wiggins	365	859	1,382
Windsor	1,852	1,811	1,548
Nebraska			
Chappell	1,061	1,093	1,297
Kimball	1,711	1,725	2,048
North Platte	12,061	12,429	15,433
Ogallala	1,631	3,159	3,456
Paxton	507	551	606
Potter	515	387	421
Sidney	3,306	3,388	4,849
Sutherland	753	862	948
Wyoming			
Albin	-	160	208
Burns	216	253	216
Cheyenne	17,361	22,474	31,935
Pine Bluffs	670	771	846

USES OF WATER RESOURCES

An estimated 2,800,000 acre-feet of water per year are supplied from surface and ground sources for domestic and industrial supplies, and irrigation. These waters also serve for watering of livestock, fishing, and other recreational purposes, development of hydroelectric power and the removal and ultimate disposal of municipal and industrial wastes. Water contributes much to the natural scenery of the region, and is used extensively for almost all purposes except navigation. Conservation has permitted a very high degree of water use development.

Provision for an adequate domestic and industrial surface water supply to serve 137.89 M.G.D. to about 633,000 people residing in 28 communities has been a major problem. Approximately 75 percent of the domestic water consumers are supplied through the Denver public system (table 4). At the present time about 30 percent of the Denver supply is obtained by transmountain diversion via the Moffat Tunnel. The remainder is taken from the South Platte River and from Cherry and Bear Creeks. Twenty-seven other communities located in mountainous regions or within a short distance of mountain streams, with an aggregate population of about 152,000, also obtain their water supply from streams or surface impoundments (Map No. 2). No public water supplies are taken directly from streams in the plains regions, probably because streams have unreliable flows, contain excessive concentrations of minerals, or are highly polluted. Surface water supplies for the most part are obtained from mountain streams not subject to excessive pollution. Municipalities of the South Platte Basin use about 258,000 acre-feet of water annually with about 225,000 acre-feet of it derived from surface sources and the remainder from ground supplies. Forty-nine municipalities (table 5) obtain their supplies from wells and serve 62,000 people 12.10 M.G.D.

Because of the difficulty of obtaining adequate private water supplies industries usually are served by municipal systems. However, some of the major industrial water users, such as sugar refineries, have their own wells or pump water from irrigation ditches. The water requirements of industry not connected to municipal systems are estimated at 50,000 acre-feet annually.

Irrigation requires the greatest volume of water. It has been estimated that 1,405,000 acres were under irrigation in 1944, when 2,087,000 acre-feet of water was used. Undoubtedly, more water would have been utilized had it been available. This acreage has not been materially increased. It is anticipated that when completed the Colorado-Big Thompson transmountain diversion will supply approximately 260,000 additional acre-feet of water for irrigation and other purposes below Platteville, Colorado. If the Blue-South Platte project is constructed an additional 430,000 acre-feet annually, diverted from the western slope, will become available for use in the area from the North Fork of the South Platte to Fort Lupton, Colorado, and will add about 49,000 acre-feet annually to the Denver municipal supply.

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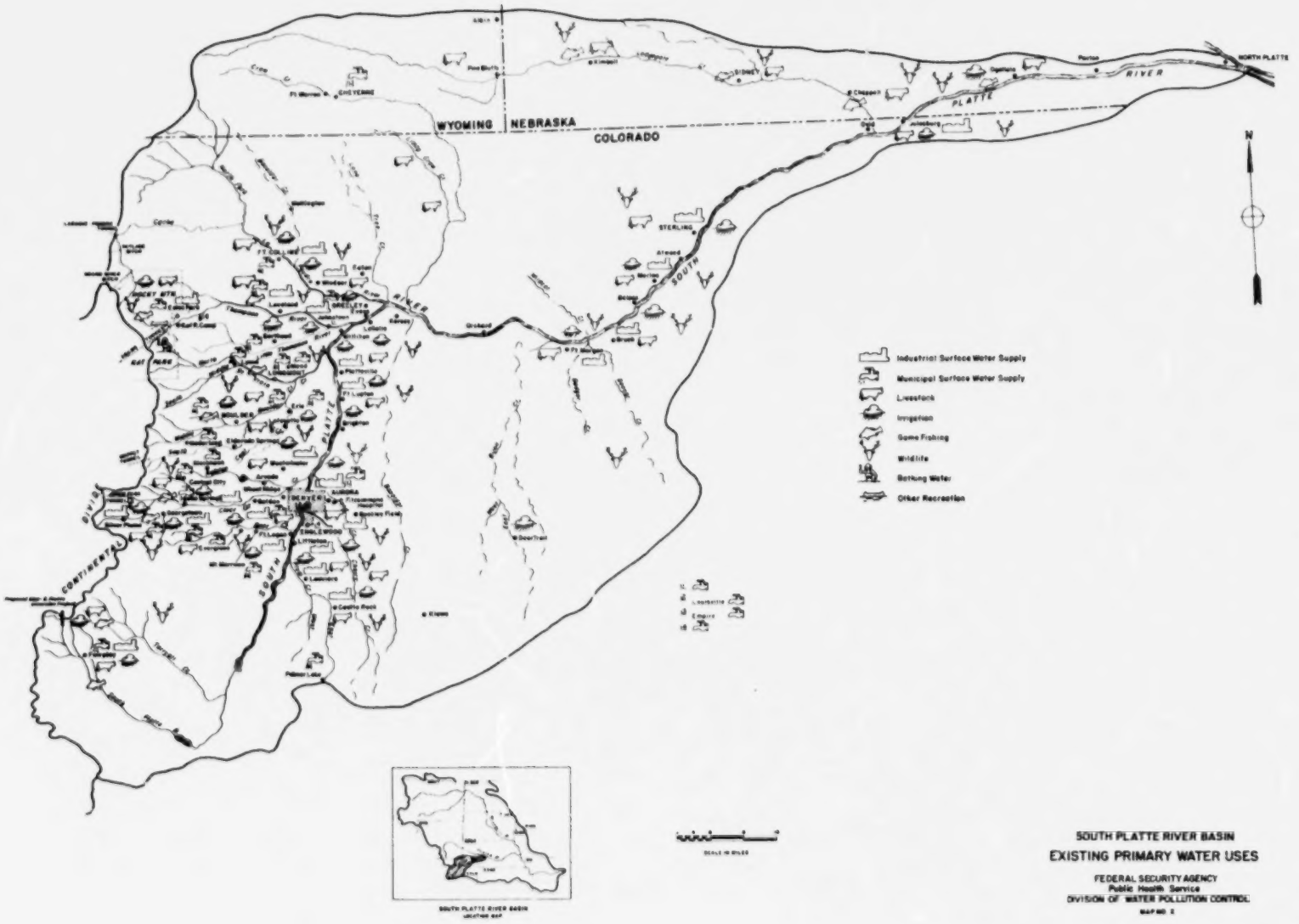


SOUTH PLATTE RIVER BASIN
EXISTING PRIMARY WATER USES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

Table 4. South Platte River Basin - Municipal surface water supplies

Municipality and location	Source	Treatment[1]	Estimated population served	Design capacity M. G. D.	Average consumption M. G. D.
Berthoud, Colo.	Thompson River via Handy Ditch	CSFD	900	2.00	0.20
Blackhawk, Colo.	Creek and springs	None	400	0.10	0.04
Boulder, Colo.	Boulder Creek (Imp. reservoir)	None	20,000	6.00	5.00
Central City, Colo.	Springs and creeks	D	300	0.10	0.05
Cheyenne, Wyo.[2]	Crow Creek	DCFS	35,000	12.00	6.00
Denver, Colo.[2]	South Platte River Fraser River	DCFS	481,000	189.00	99.00
Empire, Colo.	Mad Creek	None	175	0.06	0.01
Englewood, Colo.	South Platte River	SHCFD	20,000	10.4	10.00
Erie, Colo.	Irrigation ditch	DCFS	1,200	1.00	0.07
Estes Park, Colo.	Glacier Creek	DS	6,000[a]		0.50[a]
	Black Canyon	None	(1,200)[b]	1.00	(0.07)[b]
Evergreen, Colo.	Bear Creek	DF	500	0.20	0.04
Fairplay, Colo.	Beaver Creek and spring	D None	800	0.30	0.25
Fort Collins, Colo.	Cache la Poudre River	CSFD	18,000	9.00	4.00
Georgetown, Colo.	Leavenworth Reservoir	D	400	0.08	0.03
Golden, Colo.	Long Lake	CSFD	3,500	0.05	1.00
Greeley, Colo.[3]	North Fork Cache la Poudre River	CSFD	18,000	9.00	5.00
Idaho Springs, Colo.	Soda Creek and Chicago Creek	DF	2,500	0.25	0.10
Johnstown, Colo.	Thompson River via Home Supply Ditch	DCFS	1,000	1.50	0.60
Lafayette, Colo.	South Boulder Creek Irrigation Canal	CSFD	2,500	0.50	0.50

Table 4. South Platte River Basin - Municipal surface water supplies (cont'd)

Municipality and location	Source	Treatment[1]	Estimated population served	Design capacity M. G. D.	Average consumption M. G. D.
Longmont, Colo.	North and So.St. Vrain	CSFD	8,500	5.00	2.00
Louisville, Colo.	South Boulder Creek Marshall Lake (Irrigation Canal)	CSFD	2,500	1.00	0.60
Loveland, Colo.	Thompson River	CSFD	8,000	6.00	2.50
Lyons, Colo.	North St. Vrain Creek	FD	700	0.25	0.14
Mead, Colo.	St. Vrain Creek	FD	190	0.30	0.10
Mount Morrison, Colo.	Bear Creek	DF	250	0.25	0.05
Nederland, Colo.	Boulder Creek	D	400	0.25	0.05
Palmer Lake, Colo.	Imp. Thompson Creek Creeks	None	270	0.25	0.05
Silver Plume, Colo.	Clear Creek	None	140	0.05	0.01
Total for 28 supplies			633,125		137.89

[1]Treatment - A - Aerated
C - Coagulated
D - Chlorinated
F - Filtered
H - Softened
S - Settled

[2]Serves Sheridan, Aurora and Fitzsimmons Hospital and unincorporated areas including Lakewood and Wheatland.

[3]Serves Windsor, Evans and Timnath.

[a]Summer.

[b]Winter.

Table 5. South Platte River Basin - Municipal water supplies taken from ground sources

Municipality	Source	Treatment	Est.pop. served (1949)	Rated capacity M. G. D.	Average consumption M. G. D.
Colorado					
Arvada	Artesian wells	None	1,500	-	0.15
Ault	Wells	None	780	0.15	0.10
Brighton	Wells	D	4,200	1.50	1.00
Brush	Wells	None	2,550	1.00	0.45
Castle Rock	Shallow wells	None	600	1.00	0.50
Crook	Shallow wells	D	250	0.06	0.05
Dacono	Deep wells	D	300	0.10	0.02
Deer Trail	Deep well	None	450	0.10	0.09
Eaton	Shallow well	None	1,530	0.75	0.22
Firestone	Deep wells	None	260	0.06	0.02
Ft. Lupton[1]	Wells	None	1,700	0.65	0.25
Ft. Morgan	Deep well	None	5,000	2.00	1.37
Frederick	Wells	D	700	0.10	0.09
Grover	Well	None	160	0.04	0.02
Hudson	Well	None	400	0.15	0.06
Iliff	Deep wells	None	300	0.10	0.03
Julesburg	Wells	None	1,800	0.50	0.40
Keenesburg	Deep well	D	300	0.10	0.03
Kersey	Well	None	300	0.05	0.04
LaSalle	Wells	None	800	1.15	0.15
Littleton	Infiltration	D	2,500	1.44	0.35
Merino	Wells	None	240	0.50	0.03
Milliken	Deep well	None	500	0.25	0.06
Nunn	Well	None	180	0.10	0.03
Ovid	Shallow well	None	700	0.10	0.08
Peetz	Well	None	210	0.10	0.03
Pierce	Well	None	350	0.05	0.03
Platteville	Wells	None	600	0.25	0.10
Sedgwick	Well	None	350	0.25	0.05
Sterling	Wells	D	7,500	3.00	1.80
Ward	Spring	None	120	0.02	0.01
Wellington	Shallow wells	D	400	0.25	0.05
Westminister	Well	None	-	-	-
Wyoming					
Albin	Deep well	None	160	-	0.02
Burns	Deep well	None	150	-	0.02
Pine Bluffs	Deep well	None	700	-	0.07

Table 5. South Platte River Basin - Municipal water supplies taken from ground sources (cont'd.)

Municipality	Source	Treatment	Est.pop. served (1949)	Rated capacity M. G. D.	Average consumption M. G. D.
Nebraska					
Big Springs	Wells	None	500	0.90	0.10
Bushnell	Deep well	None	200	0.38	0.02
Chappell	Wells	None	1,000	0.97	0.50
Dix	Deep well	None	150	0.02	0.01
Hershey	Well	None	350	0.27	0.03
Kimball	Wells	None	1,600	1.00	0.35
Lodgepole	Wells	None	300	0.75	0.06
North Platte	Wells	None	12,000	7.33	2.00
Ogallala	Deep wells	None	2,000	1.50	0.80
Paxton	Deep wells	None	460	0.77	0.02
Potter	Wells	None	300	0.86	0.01
Sidney	Wells	None	3,450	2.33	0.30
Sutherland	Wells	None	600	0.46	0.13
Total - 49 supplies			61,450		12.10

[1]Supplies F.S.A. Migratory Camp (900 people served)

Treatment - D - Chlorinated.

Water resources of the Basin have great recreational potential. It is estimated that the tourist trade gross business value was nearly $200,000,000 in the State of Colorado in 1949, of which a goodly portion is credited to that section of Colorado within the South Platte Basin. In their natural state, headwater streams support an excellent fishery. Excessive sport fishing, together with pollution, has resulted in some depletion of the fishery sources in the Basin. To counteract these conditions, the Colorado Game and Fish Department has established fish hatcheries to periodically restock streams with game fish. The most popular fishing spots are to be found in the headwaters of the Cache la Poudre and Thompson Rivers; the St. Vrain, Boulder, and Bear Creeks; and in the South Platte River and its tributaries above Watertown. Clear Creek, according to historical records, provided an excellent fish habitat prior to the extensive mining developments along its banks. Pollution resulting from ore processing operations is now being confined; however, in the earlier days there was little control of the disposal of mine tailings and processing wastes, and profound, prolonged changes occurred in the character of the stream beds.

Water resources for recreational use have been enhanced by construction of a number of reservoirs in or adjacent to the Rocky Mountain National Park, particularly the Granby, Shadow Mountain, Mary's Lake, Estes and Horsetooth impoundments. The recreational potential for fishing, boating, and tourist use of some of the impoundments is great.

Production of hydroelectric power is an important use of water; power plants are located on South Clear Creek, Clear Creek, Byer Creek, Fall River, Middle Boulder Creek, Boulder Creek, North St. Vrain Creek, Big Thompson River and on a number of very small streams. Total installed hydroelectric capacity of the South Platte Basin is estimated at 77,400 kw.

Waterways of the Basin also serve to supply the needs of wildlife, including large and small game. A considerable number of ducks and geese use the waterways as resting places during their migratory flights.

Table 6. South Platte River Basin - Basic data on sources of municipal pollution

Stream and municipality[1]	River miles from mouth	Population served	Total population equivalent	Treatment provided	Adequacy of treatment: Ca'y	Adequacy of treatment: Oper.	Population equivalent discharged	Project needs	Current status of municipal action
South Platte River	320.9								
Plum Creek									
Castle Rock, Colo.	29.5	740	740	Lagoon	Unsat.	Unsat.	(a)	Replace	Inactive
Louviers, Colo.	21.0	160	160	Primary	Sat.	Sat.	100	None	-
S.D. #21 (Littleton)	314.0	6,300	6,300	Secondary	Unsat.	Sat.	3,000	Enlarge and add'l treatment	Inactive
S.D. #20 (S. Englewood)	312.0	-	-	(b)	-	-	-	-	-
Bear Creek	311.3								
Fed. Correctional Inst.,Colo.	8.5	800	800	Secondary	Unsat.	Sat.	200	Additional treatment	Inactive
Ft. Logan, Colo.	3.0	3,000	3,000	Secondary	Sat.	Sat.	300	None	-
Loretto Heights College, Colo.	1.0	400	400	Primary	Unsat.	Unsat.	280	Additional treatment	Inactive
Denver, Colo.	299.2	415,800)							
S.D. #6 (Mt. View)		900)							
S.D. #3 (Columbia Gardens)		600)							
S.D. #7 (Edgewater)		3,000)							
S.D. #8 (E. Jefferson)		1,900)							
S.D. #9 (E. Jefferson Assoc.)		300)							
S.D. #10 (E. Lakewood)		750)							Under
S.D. #11 (Alameda)		750)	621,000	Primary[c]	Sat.	Sat.	41,500	Additional treatment	construction
S.D. #12 (W. Alameda)		800)							
S.D. #13 (Byland Park)		750)							
S.D. #14 (Lakewood)		10,700)							
S.D. #15 (W. Lakewood)		900							
S.D. #16 (S. Lakewood)		1,800)							
S.D. #19 (Englewood)		18,000)[b]							
S.D. #26 (N. Washington)		1,800)							
S.D. #28 (Hoffman Heights)		2,700)							
		467,980							
Sand Creek	297.0								
Tollgate Creek	6.0								
Hadley Field, Colo.	6.5	1,900	1,900	Secondary	Sat.	Sat.	190	(g)	Inactive
S.D. #29 (Tollgate)	5.0	250	250	None	-	-	250	New plant	Preliminary plans
Fitzsimmons Hospital, Colo.	1.2	8,000	8,000	Secondary	Sat.	Sat.	250	None	-
S.D. #27 (Aurora)	6.8	17,000	17,000	Primary	Unsat.	Unsat.	11,900	Replace	Under construction
East Denver Plant, Colo.	5.4	25,000	25,000	Secondary	Unsat.	Sat.	17,500	Additional treatment	Inactive
Clear Creek	296.0								
Silver Plume, Colo.	53.5	140	140	None	-	-	140	New plant	Inactive
Georgetown, Colo.	51.0	120	120	None	-	-	120	New plant	Inactive
Idaho Springs, Colo.	37.0	1,900	1,900	None	-	-	1,900	New plant	Inactive
North Fork Clear Creek	28.0								
Central City, Colo.	9.0	200	200	None	-	-	200	New plant	Inactive
S.D. #17 (Golden)	18.0	6,200	6,200	None	-	-	6,200	(d)	(d)
S.D. #16 (Prospect Valley)		(1,800)[e]	-	-	-	-	-	-	-
S.D. # 4 (Wheatridge)	8.0	2,300	2,300	Secondary	Sat.	Sat.	400	Additional treatment	Inactive
S.D. # 3 (Fruitdale)		1,000	1,000	None	-	-	1,000	New plant	Under construction
S.D. # 2 (Clear Creek)		3,000	3,000	None	-	-	3,000	New plant	Under construction
Ralston Creek	7.0								
S.D. #1 (Arvada)	1.0	2,400	4,280	Primary	Unsat.	Unsat.	2,800	Add'l treatment	Under construction
S.D. #22 (Palmer		2,000	2,000	Primary	Sat.	Sat.	1,300	Additional treatment	Inactive
Intermittent Stream									
S.D. #23 (Westminster)		3,800	3,800	Secondary	Unsat.	Unsat.	1,500	Add'l treatment	Preliminary plans
S.D. #24 (Brighton)	284.0	4,800	7,000	Secondary	Unsat.	Sat.	4,500	Additional treatment	Inactive
Fort Lupton, Colo.	272.0	9,200	8,400	Primary	Unsat.	Sat.	3,800	Additional treatment	Inactive
Platteville, Colo.	264.4	700	700	None	-	-	700	New plant	Inactive
St. Vrain Creek	253.0								
Lyons, Colo.	37.0	1,430	1,430	None	-	-	1,430	New plant	Under construction[f]
Longmont, Colo.	28.8	8,000	8,000	Secondary	Unsat.	Sat.	4,000	Additional treatment	Inactive
Boulder Creek	29.0								
Boulder, Colo.	19.6	21,400	21,400	Primary	Unsat.	Unsat.	15,000	Enlarge and add'l treatment	Plans approved
Coal Creek	7.0								
Lafayette, Colo.	8.0	1,250	1,250	Primary	Unsat.	Unsat.	880	Add'l treatment	Under construction
Thompson River	248.0								
Bureau of Reclamation Camp,Colo.	58.5	200	200	Secondary	Unsat.	Sat.	320	Additional treatment	Inactive
Estes Park, Colo.	58.3	6,000[g]	6,000	Secondary	Unsat.	Sat.	2,400	Additional treatment	Inactive
Loveland, Colo., Plant #1	32.9	2,000	2,000	Secondary	Unsat.	Unsat.	1,000	Additional treatment	Inactive
Plant #2	22.7	6,000	9,780[h]	Secondary	Unsat.	Sat.	3,000	Additional treatment	Inactive
Little Thompson River	8.8								
Berthoud, Colo.	12.9	1,000	1,000	Secondary	Unsat.	Unsat.	400	Additional treatment	Inactive
Johnstown, Colo.	2.0	900	1,380	None	-	-	1,380	New plant	Inactive
Milliken, Colo.	8.8	800	800	None	-	-	800	New plant	Inactive
La Salle, Colo.	239.9	800	800	Primary	Unsat.	Unsat.	700	Additional treatment	Inactive
Cache la Poudre River	234								
Wellington, Colo.	-	840	840	Primary	Unsat.	Unsat.	400	Additional treatment	Inactive
Ft. Collins, Colo.	37.8	18,000	19,280	Secondary	Sat.	Sat.	8,400	(g)	Inactive
Windsor, Colo.	21.4	2,000	2,000	Secondary	Unsat.	Sat.	800	Additional treatment	Inactive
Tributary	7.0								
Eaton, Colo.	7.0	1,300	1,300	Primary	Unsat.	Sat.	910	Additional treatment	Inactive
Greeley, Colo.	4.4	21,000	28,180	Primary	Unsat.	Sat.	15,000	Additional treatment	Inactive
Kersey, Colo.	251.0	300	300	Lagoon	Sat.	Sat.	(a)	None	-
Crow Creek	227.0								
Cheyenne, Wyo.	76.0	39,000	39,000[i]	Secondary	Sat.	Sat.	6,000	None	-
Bijou Creek	189.5								
Deer Trail, Colo.	46.0	390	390	None	-	-	390	New plant	Inactive
Ft. Morgan, Colo.	164.8	8,800	8,700	Lagoon	Unsat.	Unsat.	(a)	None	-
Brush, Colo.	178.8	2,500	2,500	Primary	Unsat.	Unsat.	2,200	Additional treatment	Inactive
Merino, Colo.	166.8	300	300	None	-	-	300	New plant	Inactive
Sterling, Colo.	153.0	7,800	7,800	Primary	Unsat.	Sat.	5,800	Additional treatment	Inactive
Crook, Colo.	122.0	250	250	Primary	Sat.	Sat.	180	None	-
Lodgepole Creek	90.0								
Albin, Wyo.	-	200	200	Lagoon	Sat.	Sat.	(a)	None	-
Pine Bluffs, Wyo.	121.0	800	800	Lagoon	Sat.	Sat.	(a)	None	-
Kimball, Nebr.	101.0	2,000	2,000	Secondary	Unsat.	Unsat.	800	(g)	Inactive
Sidney, Nebr.	88.7	3,000	3,000	Secondary	Sat.	Sat.	1,000	(g)	Inactive
Chappell, Nebr.	12.0	1,200	1,200	Secondary[j]	Unsat.	Sat.	800	Add'l treatment	Under construction
Ovid, Colo.	0.2	700	700	None	-	-	700	New plant	Inactive
Julesburg, Colo.	90.0	1,800	1,800	None	-	-	1,800	New plant	Inactive
Ogallala, Nebr.	87.2	2,000	2,000	Secondary[k]	Sat.	Unsat.	2,000	(g)	Inactive
Totals		707,320	881,720				480,070		

[1] All sources of pollution listed as "S.D." are Sanitatio Districts located in Colorado.

[2] Disinfection recommended for effluents of four existing secondary treatment plants now in operation and the Ogallala treatment plant which requires reactivation.

[3] Does not discharge to stream; effluent to lagoon.

[4] Englewood is constructing a new secondary treatment plant which will also treat wastes from South Englewood.

[5] Denver has an intermediate treatment plant which reduces B.O.D. by about 40%

[6] New plant under construction which will treat Coors industrial wastes and municipal wastes from Golden.

[7] Sanitation district being organized.

[8] Lyons is constructing a new primary treatment plant. Protection of downstream water uses indicates that secondary treatment and efficient chlorination are necessary.

[9] This figure represents the population served during the summer tourist season. During winter season the 880 permanent residents are served by the primary portion of the treatment plant which effects a 30 percent reduction in B.O.D.

[10] Increase of 2,780 P.E. due to seasonal cannery waste discharging to municipal sewerage.

[11] Includes Ft. Warren.

[12] Secondary plant; however sand filters are being by-passed.

[13] Plant not in operation.

POLLUTION CONTRIBUTED TO WATER RESOURCES

Pollution of Basin streams results from organic and inorganic wastes including silt. Communities contribute a large and increasing segment to the pollutional load. In the decade 1940-1950, the Basin's population increased 28 percent from 660,000 to 840,000 and a major part of this increment settled in urban areas, particularly in metropolitan Denver. The population served by municipal sewerage is estimated at 707,320. Industrial plants connected to municipal sewers raise the combined municipal load in population equivalents to 891,720 (table 6 and Map 3). Sixteen primary treatment plants and 27 secondary treatment works reduce the over-all municipal pollution about 46 percent (table 7). Treatment plant effluents, in addition to untreated wastes from 16 communities, account for 480,070 population equivalents that are discharged to Basin streams.

Industry contributes the largest part of the Basin's total wastes. Table 8 and Map 3 contain basic data on sources of pollution originating in industries which seasonally discharge an estimated 4,193,410 population equivalents directly to streams. The table, while containing all available data, may not be complete. However, it does include all significant sources of industrial pollution.

There are 12 beet sugar factories, 11 of which seasonally contribute an estimated 4,110,000 population equivalents. Six of the plants are Steffen house, 5 are straight house, and 1 plant at Johnstown recovers, through a special process, additional sugar from Steffen house molasses obtained from the other plants. It is interesting to note that the latter plant is the only one in the world known to be operating this process. Use of Steffen house discard reduces the amount of wastes which otherwise would have been sent to streams.

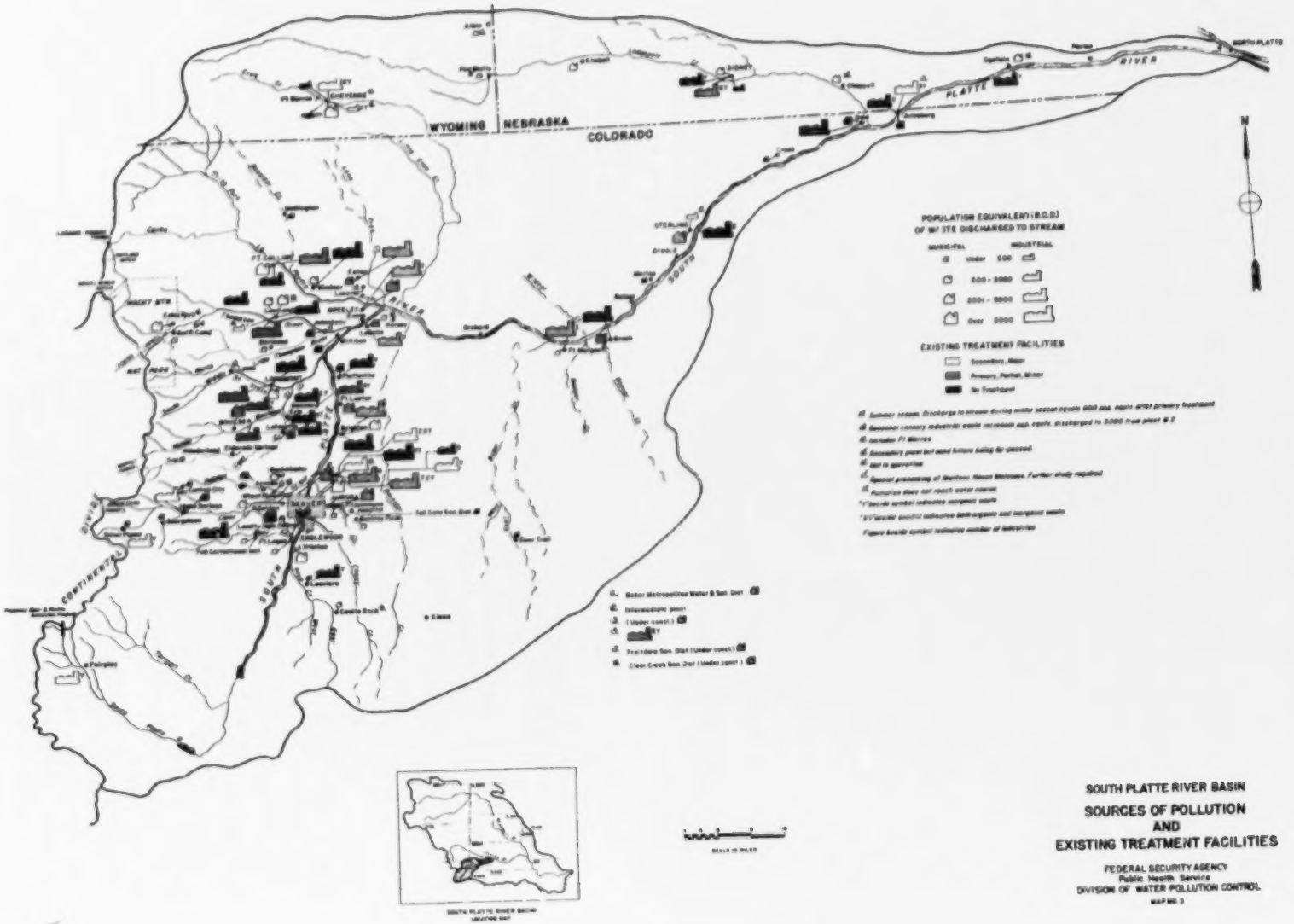
More effort should be directed toward reduction of approximately 33,000 population equivalents of cannery waste, which is discharged to streams with little attempt to reduce the pollutional load.

Table 7. South Platte River Basin - Summary of existing municipal* treatment facilities

Degree of treatment provided	Number		Population served
	Municipalities	Plants	
Secondary	26	27	149,240
Primary	31**	16	538,650
No treatment	16		19,430

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

**15 sanitary districts served by Denver treatment plant.



SOUTH PLATTE RIVER BASIN

SOURCES OF POLLUTION AND EXISTING TREATMENT FACILITIES

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

MAP NO. 3

Table 6. South Platte River Basin - Basic data on sources of industrial pollution

Location and name of industry	Type of industry: Major	Type of industry: Specific	Type of waste produced	Treatment or other pollution control measures: Degree	Treatment or other pollution control measures: Adequacy	Population equivalent (B.O.D.) discharged to watercourse	Receiving stream	Treatment needs	Status
Brighton, Colo.	Food & kindred products								
Rumer-Simpson		Cannery	Organic	None	-	7,800	S.Platte River	New plant (secondary)	Inactive
Denver, Colo.	Food & kindred products								
Great Western Mushroom Co.		Cannery	Organic	Lagoon	Sat.	0	-	None	-
Fort Collins, Colo.	Food & kindred products								
Dreher Pickle Co.		Cannery	Organic	None	-	2,800	Cache la Poudre River	New plant (secondary)	Inactive
Larimer County, Colo.	Food & kindred products								
Thorr, Products Co.		Cannery	Organic	None	-	2,100	Big Thompson River	New plant (secondary)	Inactive
Longmont, Colo.	Food & kindred products								
Rumr-Simpson		Cannery	Organic	None	-	18,000	St. Vrain Creek	New plant (secondary)	Inactive
Loveland, Colo.	Food & kindred products								
Rumer-Simpson		Cannery	Organic	None	-	2,800	Big Thompson River	New plant (secondary)	Inactive
Neville's Cherry Cider	Food & kindred products	Cannery	Organic	Major	Sat.	0	-	None	-
Wolaver Co.	Food & kindred products	Cannery	Organic	Major	Sat.	0	-	None	-
Golden, Colo.	Food & kindred products	Malt and beer	Organic	None	-	12,650	Clear Creek	New plant (secondary)	Under construction
Adolph Coors[1]									
Near Denver, Colo.	Food & kindred products	Meat	Organic	Minor	Unsat.	1,680	South Platte River	New plant (secondary)	Inactive
Altberger Packing Co.	Food & kindred products	Meat	Organic	Minor	Unsat.	760	South Platte River	New plant (secondary)	Inactive
Capitol Rendering Co.	Food & kindred products	Meat	Organic	Minor	Unsat.	760	South Platte River	New plant (secondary)	Inactive
Duffler Horse Packing Co.	Food & kindred products	Meat	Organic	Minor	Unsat.	760	South Platte River	New plant (secondary)	Inactive
Litvak Meat Co.	Food & kindred products	Meat	Organic	Minor	Unsat.	3,810	South Platte River	New plant (secondary)	Inactive
National Food Stores, Inc.	Food & kindred products	Meat	Organic	Minor	Unsat.	4,800	South Platte River	New plant (secondary)	Inactive
Sammett Packing Co.	Food & kindred products	Meat	Organic	None	-	600	South Platte River	New plant (secondary)	Inactive
Fort Morgan, Colo.	Food & kindred products	Meat	Organic	Minor	Unsat.	430	Irrigation ditch	Addition (secondary)	Inactive
H. & D. Packing Co.									
Tiemon Packing Co.	Food & kindred products	Meat	Organic	Minor	Unsat.	600	Irrigation ditch	Addition (secondary)	Inactive
Greeley, Colo.	Food & kindred products	Meat	Organic	Minor	Unsat.	1,700	Cache la Poudre River	Addition (secondary)	Inactive
Greeley Rendering Plant									
Sterling, Colo.	Food & kindred products	Meat	Organic	Lagoon	Sat.	0	-	None	-
Sterling Packing Co.									
Sterling Rendering Plant	Food & kindred products	Meat	Organic	None	-	1,280	Irrigation ditch	New plant (secondary)	Inactive
Near Denver, Colo.	Food & kindred products	Milk	Organic	Minor	Unsat.	910	Big Dry Creek	New plant (secondary)	Inactive
Brookridge Farms									
City Park Farm Dairy	Food & kindred products	Milk	Organic	None	-	830	Cherry Creek	New plant (secondary)	Inactive
Garden Farms Dairy	Food & kindred products	Milk	Organic	None	-	980	Sand Creek	New plant (secondary)	Inactive
Julesburg, Colo.	Food & kindred products	Misc.	Inorganic	None	-	-	Ditch	New plant (pond or lagoon)	Inactive
H. H. Heimbalt, Jr.									
Platte Valley Potato Growers Ass'n	Food & kindred products	Misc.	Inorganic	Lagoons	Sat.	-	-	None	-
LaSalle, Colo.	Food & kindred products	Misc.	Inorganic	Minor	Unsat.	-	Irrigation ditch	Addition (pond or lagoon)	Inactive
Farr Farms Potato Co.									
Lucerne, Colo.	Food & kindred products	Misc.	Inorganic	Minor	Unsat.	-	Irrigation ditch	Addition (pond or lagoon)	Inactive
Lucerne Potato Growers									
Weld County Potato Growers Ass'n	Food & kindred products	Misc.	Inorganic	Minor	Unsat.	-	Irrigation ditch	Addition (pond or lagoon)	Inactive
Platteville, Colo.	Food & kindred products	Misc.	Inorganic	None	-	-	Ditch	New plant (pond or lagoon)	Inactive
Platteville Potato Ass'n									
Greeley, Colo.	Food & kindred products	Misc.	Organic	Minor	Unsat.	2,300	Cache la Poudre River	New plant (secondary)	Inactive
Associated Seed Growers, Inc.									
Brighton, Colo.	Food & kindred products	Sugar	Organic	Primary	Unsat.	190,000	South Platte River	Addition (secondary)	Inactive
Great Western Sugar Co.									
Brush, Colo.	Food & kindred products	Sugar	Organic	None	-	280,000	Beaver Creek	New plant (secondary)	Inactive
Great Western Sugar Co.									
Eaton, Colo.	Food & kindred products	Sugar	Organic	Minor	Unsat.	140,000	Nameless Creek	Addition (secondary)	Inactive
Great Western Sugar Co.									
Fort Collins, Colo.	Food & kindred products	Sugar	Organic	Primary	Unsat.	710,000	Cache la Poudre River	Addition (secondary)	Inactive
Great Western Sugar Co.									
Fort Morgan, Colo.	Food & kindred products	Sugar	Organic	Primary	Unsat.	450,000	South Platte River	Addition (secondary)	Inactive
Great Western Sugar Co.									
Greeley, Colo.	Food & kindred products	Sugar	Organic	Primary	Unsat.	180,000	Cache la Poudre River	Addition (secondary)	Inactive
Great Western Sugar Co.									
Johnstown, Colo.	Food & kindred products	Sugar	Organic	-	-	-	-	(2)	-
Great Western Sugar Co.									
Longmont, Colo.	Food & kindred products	Sugar	Organic	Primary	Unsat.	700,000	St. Vrain Creek	Addition (secondary)	Inactive
Great Western Sugar Co.									
Loveland, Colo.	Food & kindred products	Sugar	Organic	Primary	Unsat.	840,000	Big Thompson River	Addition (secondary)	Inactive
Great Western Sugar Co.									
Ovid, Colo.	Food & kindred products	Sugar	Organic	None	-	390,000	Lodgepole Creek	New plant (secondary)	Inactive
Great Western Sugar Co.									
Sterling, Colo.	Food & kindred products	Sugar	Organic	None	-	880,000	South Platte River	New plant (secondary)	Inactive
Great Western Sugar Co.									
Windsor, Colo.	Food & kindred products	Sugar	Organic	None	-	280,000	Cache la Poudre River	New plant (secondary)	Inactive
Great Western Sugar Co.									
Denver, Colo.	Fabricated metal products	Ordnance	Inorganic	Lagoon	Sat.	-	-	None	-
Rocky Mountain Arsenal									
Lowry, Colo.	Fabricated metal products	Ordnance	Inorganic	None	-	-	-	Data incomplete	-
Dupont Remmers & Co., Inc.									
Denver, Colo.	Fabricated metal products	Transportation	Organic and inorganic	Minor	Unsat.	-	South Platte River	New plant (primary)	Plans initiated
C.B. & Q. R.R. Shops									
Colorado & Southern R.R. Shops	Fabricated metal products	Transportation	Organic and inorganic	Minor	Unsat.	-	South Platte River	New plant (primary)	Inactive
Rio Grand R.R. Shops	Fabricated metal products	Transportation	Organic and inorganic	Minor	Unsat.	-	South Platte River	New plant (primary)	Plans initiated
Santa Fe R.R. Shops	Fabricated metal products	Transportation	Organic and inorganic	Minor	Unsat.	-	South Platte River	New plant (primary)	Inactive
Dacono, Colo.									
Boulder Valley Coal Co.			Mine						
Boulder Valley #6 Mine	Mining	Coal	drainage	Pond	Sat.	-	-	None	-
Consolidated Coal & Coke Co.			Mine						
Dunn Mine	Mining	Coal	drainage	Pond	Sat.	-	-	None	-
Graden Coal Co.			Mine						
Graden Mine	Mining	Coal	drainage	Pond	Sat.	-	-	None	-
McNeil Coal Co.			Mine						
Sterling Mine	Mining	Coal	drainage	None	-	-	Dry Creek	New plant (pond or lagoon)	Inactive
Shamrock Coal Co.			Mine						
Shamrock Mine	Mining	Coal	drainage	None	-	-	Irrigation ditch	New plant (pond or lagoon)	Inactive
Erie, Colo.									
Clayton Coal Co.			Mine						
Lincoln Mine	Mining	Coal	drainage	None	-	-	Dry Creek	New plant (pond or lagoon)	Inactive
Harrison Mine	Mining	Coal	Mine drainage	None	-	-	St. Vrain Creek	None	-
Washington Mine	Mining	Coal	Mine drainage	Pond	Sat.	-	-	None	-
Erie Coal Co.									
Erie Strip Mine	Mining	Coal	Mine drainage	None	-	-	-	New plant (pond or lagoon)	Inactive

Table 8. South Platte River Basin - Basic data on sources of industrial pollution (cont'd)

Location and name of industry	Type of industry: Major	Type of industry: Specific	Type of waste produced	Treatment or other pollution control measures: Degree	Treatment or other pollution control measures: Adequacy	Population equivalent (B.O.D.) discharged to watercourse	Receiving stream	Treatment needs	Status
Erie, Colo. (cont'd)									
Imperial Coal Co.									
Eagle Mine	Mining	Coal	Mine drainage	None	-	-	-	None	-
Imperial Mine	Mining	Coal	Mine drainage	None	-	-	Drainage ditch	New plant (pond or lagoon)	Inactive
Lafayette, Colo.									
Black Diamond Fuel Co.									
Black Diamond #8 Mine	Mining	Coal	Mine drainage	None	-	-	Irrigation ditch	New plant (pond or lagoon)	Inactive
Louisville-Lafayette Coal Co.									
Hi-way Mine	Mining	Coal	Mine drainage	Pond	Sat.	-	Dry Creek	None	-
Idaho Springs, Colo.									
Argo Mine	Mining	Ore dressing	Inorganic	-	-	-	-	Data incomplete	-
Arthur Fortenier's Mill	Mining	Ore dressing	Inorganic	Lagoons	Sat.	-	-	None	-
A.S. AS. Mill	Mining	Ore dressing	Inorganic	-	-	-	-	Data incomplete	-
Black Eagle Mill	Mining	Ore dressing	Inorganic	Lagoons	Sat.	-	-	None	-
Dixie Mill	Mining	Ore dressing	Inorganic	Lagoons	Sat.	-	-	None	-
Lombard Mill	Mining	Ore dressing	Inorganic	-	-	-	-	Data incomplete	-
Old Ore Processing Mill	Mining	Ore dressing	Inorganic	-	-	-	-	Data incomplete	-
Quartz-Mahoning	Mining	Ore dressing	Inorganic	-	-	-	-	Data incomplete	-
Silver Spruce Mill	Mining	Ore dressing	Inorganic	Lagoon	Sat.	-	-	None	-
Wolfbongue Mill	Mining	Ore dressing	Inorganic	-	-	-	-	Data incomplete	-
Silver Plume, Colo.									
Mile High Mining Co.	Mining	Ore dressing	Inorganic	Lagoon	Unsat.	-	-	Replace (lagoon)	Inactive
Fairplay, Colo.									
South Platte Dredging Co.	Mining	Placer	Inorganic	Lagoons	Unsat.	-	-	Replace (lagoon)	Inactive
Julesburg, Colo.									
Union Pacific R.R.	Misc.	Water softening	Inorganic	Lagoon	Sat.	-	-	None	-
Near Denver, Colo.									
Central Fibres Products Co.	Paper	-	Organic and inorganic	None	-	9,790	Burlington Ditch	New plant (secondary)	Inactive
Ray Petroleum Co.	Petroleum products	Refining	Organic and inorganic	Separator	Unsat.	2,400	Sand Creek	Addition (secondary)	Inactive
Continental Oil Co.	Petroleum products	Refining	Organic and inorganic	Mixer	Unsat.	4,400	Burlington Ditch	Addition (secondary)	Inactive
Empire Petroleum Co.	Petroleum products	Refining	Organic and inorganic	Separator and lagoons	Sat.	600	Sand Creek	None	-
Oriental Refining Co.	Petroleum products	Refining	Organic and inorganic	Separator and lagoons	Sat.	2,000	Sand Creek	None	-
Shelly Oil Co.	Petroleum products	Refining	Organic and inorganic	Separator	Sat.	0	-	None	-
Sidney, Nebr.									
Star Packing Co.	Food & kindred products	Meat	Organic	None	-	330	Lodgepole Creek	New plant (secondary)	Inactive
Sioux Ordnance Depot	Fabricated metal products	Transportation	Organic and inorganic	Mixer	Sat.	-	Lodgepole Creek	None	-
Cheyenne, Wyo.									
Union Pacific R.R.	Misc.	Water softening	Inorganic	None	-	-	Drainage ditch	New plant (pond or lagoon)	Inactive
Sidney, Nebr.									
Union Pacific R.R.	Misc.	Water softening	Inorganic	None	-	-	Lodgepole Creek	New plant (pond or lagoon)	Inactive
Cheyenne, Wyo.									
S. & S. Packing Co.	Food & kindred products	Meat	Organic	None	-	520	Crow Creek	New plant (secondary)	Inactive
Colo. & Southern R.R. Shops	Fabricated metal products	Transportation	Organic and inorganic	Pits pit and lagoon	Sat.	0	-	None	-
Union Pacific R.R. Shops	Fabricated metal products	Transportation	Organic and inorganic	None	-	-	Crow Creek	New plant (separator)	Plans initiated
Frontier Refining Co.	Petroleum products	Refining	Organic and inorganic	Separator and lagoons	Sat.	8,900	Crow Creek	None	-
Total						4,140,410			

[1] New plant under construction which will treat Coors industrial waste and municipal waste from Golden.
[2] Special processing of Stauffer Chemical wastes. Further study required.

The larger meat packing houses are located in Denver and are connected to municipal sewerage. Six smaller establishments near Denver but outside the corporate limits discharge about 12,000 population equivalents to streams.

Five of the six petroleum refineries in the Basin are located in the Denver area and four of the five discharge to natural drainage. All five maintain oil-water separators for the recovery of oil from plant wastes. Two refineries provide holding ponds. Expansion of present oil refinery capacities, now in progress, will increase the estimated 14,000 population equivalents presently discharged to streams. Improved operation of existing separators is desirable. Inadequate housekeeping at some refineries permits extensive leakage and spills. The Continental Oil Company at Denver has recorded the presence of lead in the Burlington-O'Brian Ditch in a concentration greater than 0.7 ppm. The Frontier Refinery at Cheyenne appeared interested in excluding its wastes from Crow Creek. Much cooperative action is required if the wide variety of organic and inorganic wastes from oil refineries is to be controlled.

Various industrial pollutants reach the Burlington O'Brian Ditch in the Denver area. A large paper mill in the Denver area discharges its wastes to Sand Creek after minor treatment.

Much of the silt which reaches our waterways cannot reasonably be avoided. Mountain torrents cascading over rocky stream beds erode material which is carried by the flowing waters. However, other sources of silt resulting from mining, ore processing, potato washing and, to some extent, poor land management practices, can be controlled.

Additional work is necessary to evaluate the effect of wastes from coal mining, placer gold dredging, and ore processing mills. Present stream pollution results from the disposal of wastes which contain in solution objectionable chemicals as carbonates, chlorides, sulphates; suspended powdered inorganic constituents of the processed ores; and silt from dredging operations. The discharge of "tailings" to Basin streams has been recognized as objectionable for many years, and some control of this pollution has been attempted. Most mills employ ponds to settle out the "tailings." In the Clear Creek Subbasin, the discharge of 200 gallons per minute from a large mine drain near Idaho Springs had the following characteristics (South Platte Report 1950):

Copper (Cu)	44 ppm.
Iron (Fe)	348 ppm.
Lead (Pb)	0.125 ppm.
Hardness	12,000 ppm.
pH	2.5

Additional pollution results from old tailing dumps eroded by storm runoff and high flows.

Two of the four railroads in the Denver area have initiated plans for waste treatment facilities. The Denver City Health Department has been active in developing this cooperative program which would reduce wastes discharged to streams in metropolitan Denver, and enable the railroads to reclaim oil for reuse.

DAMAGES TO WATER RESOURCES FROM POLLUTION

Pollution has damaging effects on water uses in the Basin. There is evidence to show that truck crops irrigated with sewage contaminated waters in the Denver area have much larger numbers of intestinal organisms adhering to them than do those irrigated with unpolluted waters. The probability of disease transmittal to consumers of these products is thereby much greater than with similar crops irrigated with clean water. Certain intestinal parasites may be transmitted to animals grazed on pastures irrigated with polluted water. The economic loss from the illness and death of such animals, or from their inability to produce their normal quota of beef or milk, is serious. Where dairy cattle drink or wade in contaminated water, the cost of milk production is increased as is the probability that the milk may be contaminated with pathogenic organisms. The health of farmers and field workers in the irrigated areas is also jeopardized because of their close contact with sewage polluted irrigation water.

No public water supplies are taken from surface resources below Greeley. Cities which use surface water obtain their supplies from mountain streams remote from large sources of pollution. Streams might have been used for more water supplies had less pollution existed at the time many municipal water systems were established.

Industry which requires odor-free, color-free, and relatively unpolluted waters must obtain supplies from ground sources or municipal systems since river water below Denver, or in South Platte tributary streams below principal cities, is so badly polluted that it is of little value for such use. The large quantity of organic pollution causes the water to be of poor quality for boiler purposes. Excessive slime also develops in industrial cooling systems when polluted waters are used.

Fish life has been largely destroyed in streams of the plains section by pollution and low flows. Inorganic materials from mining operations have, in some places, obliterated fishing grounds by poisoning the fish or by silting the river beds and destroying fish food. In 1934, the case Willmore vs. Chain O'Mines, Inc., was heard before the Colorado Supreme Court which held mainly in favor of the plaintiffs who claimed damage from mine tailings to their irrigated lands. In the Denver area farmers formerly complained of waters contaminated by wastes from the American Smelting and Refining Company which processed cadmium, thallium, and lead. Cadmium sulphide, a bright yellow dye, was easily discernible in irrigation waters. An attempt has been made to control the offending industrial wastes. Pollution precludes local recreational usage of reservoirs and irrigation systems.

Local nuisance problems exist at numerous places in the Basin. Odorous sludge banks have developed in Barr Lake, in the Burlington-O'Brian Diversion Canal, below many municipalities, and below sugar refineries. There have been numerous complaints regarding the foul smell of decomposing sugar beet refuse which is discharged into streams. Beet sugar company officials have recognized the nuisance

conditions at the Fort Collins and other sugar plants and are conducting research programs in an effort to reduce the effect of refinery wastes.

Nuisance conditions attributed to decomposing blood, fats, and offal discharged from some of the slaughtering houses are common when receiving streams are low. This situation is particularly bad in the South Platte River immediately below Denver. Nuisance conditions originating from domestic wastes also have been noted at Cheyenne, Wyoming; Boulder, Golden, and Greeley, Colorado. The situation at Cheyenne has been remedied by the recent construction of a new sewage treatment plant.

BENEFITS RESULTING FROM POLLUTION PREVENTION AND ABATEMENT

Substantial reduction of pollution in the South Platte Basin has been effected, yet much remains to be done. Efforts to control inorganic pollution from mining and ore processing operations have resulted in partial clearing and restoration of affected streams to good fish habitat, and to recreational and scenic usefulness.

The installation of sewage treatment at Denver has reduced to a considerable degree the odor and nuisance problem in the South Platte River below Denver. Treatment has also lowered the number of pathogenic bacteria in the stream below Denver. Yet, neither sludge banks, nuisances, nor excessive bacteria counts have been eliminated or diminished to proper limits; however, the situation is much improved over that existing prior to sewage treatment. Treatment has improved the quality of stock water and decreased nuisances below Cheyenne. Treatment at many other Colorado, Wyoming and Nebraska municipalities has likewise reduced nuisance problems.

The major organic pollution of the Basin is the waste products of beet sugar refineries. Removal of this great load of pollution would result in stream improvement during the beet processing season for the entire main stem of the South Platte River and for many of its tributaries. The beet sugar refining industry has been active in experimentation with various methods of waste treatment and conservation. The most practical of these conservation measures appear to be the drying of the pulp, separation and lagooning of lime wastes, by-products recover, from the Steffen waste, and reconditioning and reuse of pulp press and flume waters. Pulp press water has been used in lieu of clear water as make-up water for the battery supply, and to dilute molasses in Steffen houses. It is estimated that the organic wastes can be reduced by about 80 percent by these practices. The recovered by-products can be used for livestock feed, fertilizer, and human food. Steffen house discard at Great Western Sugar Company Steffen house plants is shipped to the Johnstown, Colorado, factory where additional sugar products are manufactured. In effect, potential wastes are converted to marketable products.

A very real benefit would result if contamination was removed from waters used for irrigation in the Basin. Excessive numbers of intestinal organisms in irrigation water present a very real public health hazard, involving consumers of the truck crops and workers in the fields who must handle the sewage-laden waters. The program recommended in this report would substantially reduce the disease-producing potential of irrigation waters of the South Platte Basin.

In the Denver area, railroad roundhouse and service shops discharge wastes to streams. The cooperative action of the Department of Health and Hospitals, City and County of Denver, has resulted in initiation of plans by the Chicago, Burlington, and Quincy Railroad and the Rio Grande Railroad to reclaim oil for re-use.

When a man's environment has been one of practical cleanliness he lives longer, produces more, and his enjoyment of living is greatly increased. This intangible benefit is one which cannot be neglected from either an economic or social viewpoint.

POLLUTION PREVENTION MEASURES IN EFFECT

Water pollution control agencies of Basin States have, in general, good records. Municipalities and industries in these States have shown a spirit of cooperativeness and an understanding of pollution control needs by installing numerous waste treatment plants.

Programs for training sewage plant operators have been developed by the State control agencies including consultative visits to sewage plants. The agencies have also familiarized the public regarding the effects of pollution and the needs for new or improved treatment plants. The State health agencies exercise control over the construction of municipal and industrial treatment works by requiring that plans and specifications for sewage treatment structures be submitted for approval. This requirement has protected the interests of the public and has generally resulted in municipal waste treatment works. The effects of pollution have been discussed with many local groups. Operators of sewage treatment works have been kept informed concerning new methods of treatment. A large measure of present control can be attributed to the public health educational program instituted by the State agencies.

The State pollution control agencies plan regular visits to sewage treatment works, at which time the plants are inspected and reports of their condition prepared for submission to municipal officials. Plant inspections are supplemented by occasional stream investigations in order to determine effects of contributed pollution on the biochemical and biological characteristics of the streams.

Sewage treatment works can be credited with removing about 46 percent of the municipal pollution of the Basin. Municipal treatment consists of the following: 16 primary treatment works serving about 538,650 people; 27 secondary treatment plants for about 149,240 people. Sixteen municipalities with a population of 19,430 (table 7) provide no treatment.

Adequacy of municipal and industrial treatment facilities is listed in table 9. Progress in pollution abatement is shown in table 10. From 1946 to 1952, nine municipal plants and no industrial plants were completed.

The tremendous amount of waste from the sugar refining industry during the months of October, November, December and January is virtually untreated. However, this problem is now under study by the Great Western Sugar Company. The oil refineries have oil separators at each of the six plants. Nine of the 13 meat packing or slaughtering houses have some degree of treatment; 3 of the 8 canneries and 1 of the 3 dairies provide treatment; the malted milk plant and the brewery are in the process of constructing a new treatment plant as a joint operation,

and this installation will provide treatment for Golden, Colorado; and all ore processing mills have some type of waste detention ponds. Many of these installations are inadequate, but the number of treatment plants indicates the intent of various industries to cooperate in an effort to control pollution.

Table 9. South Platte River Basin - Adequacy of existing treatment facilities

Existing treatment facilities	Number	Adequacy with relation to Capacity		Adequacy with relation to Operation	
		Satisfactory	Unsatisfactory	Satisfactory	Unsatisfactory
Municipal*	43	14	29	28	15
Industrial**	50	22	28	22	28

*Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

**Industries having separate outlets discharging wastes directly to watercourse.

Water pollution control legislation in the State of Colorado has placed the responsibility for pollution control with the State Department of Health and the State Game and Fish Department. The Health Department's powers are limited to public health aspects of water pollution control. The department has been active in the field of water pollution control but lacks personnel and funds. More detailed and broader legislation, vesting in a single State agency statutory authority to effectively deal with the problem, is desirable. The Health Department requires approval of plans for new sewage works prior to their construction. However, submission of plans cannot be required for industrial waste treatment plants where there is no connection to a municipal sewer system. The financing of sewer systems is adequately covered by municipal finance laws. Either revenue or general obligation bonds are permitted. A committee appointed by the Governor of Colorado is presently engaged in developing a comprehensive stream pollution control law to be presented for consideration at the next general assembly. New legislation which embodies the principles recommended by the Council of State Governments[1] is highly desirable.

The existing State Water Pollution Control Laws of Nebraska are inadequate for present needs. The present law limits authority of the State water pollution control agency to the public health aspects of pollution and does not apply to other detrimental pollutional effects. The Stream Pollution Control Agency's present functions are limited largely to educational or advisory services. The State Fish and Game Commission of Nebraska has jurisdiction over pollution control where such pollution has been found harmful to aquatic life. In either case there is no specific authority to issue orders against sources of pollution, and abatement action must be taken through the county attorneys.

[1]Suggested State Water Pollution Control Act and Explanatory Statement as endorsed by Council of State Governments.

Table 10. South Platte River Basin - Progress in pollution abatement

Year	State	Municipal[1]		Industrial[2]
		Plants completed	Population served	Plants completed
1946	Colorado	0	-	0
	Nebraska	0	-	0
	Wyoming	0	-	0
1947	Colorado	0	-	0
	Nebraska	1	4,900	0
	Wyoming	0	-	0
1948	Colorado	0	-	0
	Nebraska	0	-	0
	Wyoming	0	-	0
1949	Colorado	2	25,000	0
	Nebraska	1	500	0
	Wyoming	0	-	0
1950	Colorado	2	2,600	0
	Nebraska	1	530	0
	Wyoming	0	-	0
1951	Colorado	0	-	0
	Nebraska	0	-	0
	Wyoming	1	200	0
1952	Colorado	0	-	0
	Nebraska	0	-	0
	Wyoming	1	45,000	0

[1]Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

[2]Industries having separate outlets discharging wastes directly to watercourse.

State legislation authorizing financing of municipal sewage works appears to be adequate in Nebraska and permits the cities to issue mortgage bonds which are not a general obligation of the municipality but are secured by the property served by the sewer system. General obligation bonds are also authorized up to 10 percent of the assessed valuation of the taxable property within the sewered area. No limit is placed upon mortgage bonds.

An amendment enacted in February 1951 gives the State of Wyoming the most comprehensive water pollution control legislation of the States comprising the South Platte Basin. It provides a Council, composed of industrial and municipal representatives, as well as representatives of the various interested State agencies, to deal with problems of pollution. It provides that any pollution which adversely affects livestock, agricultural crops, wildlife, fish or aquatic life is considered to affect public health. Review of plans and specifications for sewerage systems and treatment plants is required by Wyoming statutes. The Department of Public Health may issue orders prohibiting the continuance of pollution. Since 1951, adequate authority to finance municipal sewerage systems by either revenue or general obligation bonds is possible in Wyoming.

Prior to this time the financing of sewage treatment plants was a difficult matter. There is some division of authority in the statutes between the State Department of Public Health and the Game and Fish Commission. The Game and Fish Commission is empowered to supervise waters of the State pertaining to the protection, management, and propagation of fish life.

POLLUTION PREVENTION MEASURES NEEDED

Present water uses, increased or additional uses possible with improved water quality, and protection of water rights and property values largely determine the pollution measures needed. The objective of a water pollution control program is to preserve or reclaim water to best serve these interests. Treatment requirements, like other aspects of water resources development and conservation, are generally influenced by economic considerations, intangible moral obligations, aesthetic values, and nuisance conditions which exert powerful and salutary influences on the justification of waste treatment facilities.

Water quality objectives have been fairly well developed for such water uses as domestic and industrial water supplies, recreation, bathing, and support of fish life. Water quality objectives are less well defined for other uses. However, quality objectives for the various water uses have been established as tentative guides for both municipal and industrial waste treatment by the State water pollution control agencies of the 10 Missouri Basin States, which include Colorado, Nebraska, and Wyoming.

Among the more important objectives of a water pollution control program is the protection of water quality in streams used as sources of public water supplies. The quality of raw water is an important factor in the design of water treatment facilities and in their operation and maintenance. The factor of safety which can be incorporated in the best water treatment facility varies inversely with the concentration of bacteria and toxic elements in the source of supply. Therefore, public health and waterworks officials generally measure water quality in terms of its bacteriological, physical, and chemical characteristics. While definite standards of raw water quality have not been adopted, the Manual of Recommended Water Sanitation Practice, Public Health Service Bulletin No. 296, 1946, recommends the following guides: Underground waters not subject to any possible contamination and meeting in all respects the requirements of the Public Health Service Drinking Water Standards as shown by satisfactory, regular and frequent sanitary inspections and laboratory tests, require no treatment. Underground or surface waters subject to a low degree of contamination not averaging more than 50 coliforms (M.P.N.)* per 100 ml. of sample in any month and meeting the requirements of the Public Health Service Drinking Water Standards in all other respects should receive a minimum of simple chlorination or its equivalent. Waters which require filtration treatment for turbidity and color removal, waters of high or variable chlorine demand, and

*Most probable number.

waters polluted by sewage to such an extent as to be inadmissible in the prior groups, but containing numbers of coliform bacteria averaging not more than 5,000 coliforms (M.P.N.) per 100 ml. of sample in any one month and exceeding this number in not more than 20 percent of the samples examined in any one month, should be provided complete rapid sand filtration treatment or its equivalent, together with continuous postchlorination. Waters which meet the requirements of the previous statement with respect to the limiting monthly average coliform numbers but showing numbers of coliforms exceeding 5,000 M.P.N. per 100 ml. in more than 20 percent of the samples examined during any one month and not exceeding 20,000 per 100 ml. in more than 5 percent of the samples examined during any month, should be provided auxiliary treatment in addition to filtration and postchlorination. Auxiliary treatment as used here is presedimentation or prechlorination or their equivalents either separately or combined as may be necessary. Long time storage for periods of 30 days or more represents a permanent and reliable safeguard which, in many cases, would provide something more than an effective substitute for one or both of the two other methods indicated. Waters which do not meet the requirements cited are considered unsuitable for use as sources of water supply unless they can be brought into conformance with the requirements by means of prolonged preliminary storage or some other measure of equal permanence and reliability, as heavy prechlorination, preliminary coagulation, and sedimentation.

In addition to the recommended bacterial requirements, waters for public supply should not contain toxic, taste-producing, or otherwise harmful substances, or organisms not readily and completely removed by the water treatment processes cited, and should be free of excessive amounts of acid, microscopic organisms, and organic matters causing any interference with the normal operation and efficiency of the water treatment processes. Whether or not upstream domestic and industrial waste is treated often determines the acceptability of a stream as a source of domestic or industrial supply.

Standards adopted by the Public Health Service for Drinking and Culinary Water Supplied by Common Carriers in Interstate Commerce prescribe limiting maximum concentrations of certain chemical substances inimical to public health, including the following:

Substance	Maximum concentration in parts per million
Lead	0.10
Fluoride	1.50
Arsenic	0.05
Selenium	0.05
Hexavalent chromium	0.05
Copper	3.00

These standards have received official approval by the American Water Works Association and general acceptance by official health agencies and water works authorities and are widely used as one of the guides for administration of water pollution control programs.

Also of importance are those substances which cause problems of taste and odor. Of particular concern are phenolic and related compounds, minute concentrations of which cause repugnant taste and odor in water supplies. Pollution control programs are aimed at virtual elimination of these substances in waters serving as a source of domestic supply.

Quality requirements for industrial water supply vary widely, depending upon the type and nature of industry under consideration. Of general concern are organic and biological constituents, toxic substances, and properties of corrosion, encrustation, and slime formation. Waste control measures contribute materially to improvement of water quality.

It is generally agreed that a minimum of 5.0 parts per million (ppm.) of dissolved oxygen is necessary, in those streams of the South Platte River Basin affording a suitable fishery habitat, for support of a balanced aquatic life, and that a minimum of 6.0 ppm. is desirable for trout streams. Because of limited dilution water during critical periods of low flow, secondary treatment for removal of not less than 75 percent of the Biochemical Oxygen Demand (B.O.D.), is required for most sources of pollution in the Basin. A consistent B.O.D. removal approaching 85 percent is possible with secondary treatment facilities properly designed and well operated.

Water for recreational usage should be free from floating solids, sludge banks, odors, and discoloration. Contamination of bathing waters by sewage, especially that of recent origin, is particularly objectionable. The Engineering Section, Missouri Basin Health Council, which includes representatives of the States of Colorado, Nebraska, and Wyoming, recommend the following objectives for bacteriological quality of bathing waters: "For bathing or swimming waters monthly arithmetical average 'most probable number' of coliform organisms should not exceed 1,000 per 100 ml. during any month of the recreational season; nor exceed this number in more than 20 percent of the samples examined during any such month; nor exceed 2,400 per 100 ml. on any day. For nonbathing or nonswimming waters monthly arithmetical average 'most probable number' of coliform organisms should not exceed 5,000 per 100 ml. in any month of the recreational season, nor should exceed this number in more than 20 percent of the samples examined during any such month." Sanitary surveys must continue to play the major role in pollution control programs as related to bathing waters.

The State water pollution control agencies of Colorado, Nebraska, and Wyoming, recommend as bacterial objectives for irrigation water the following:

(1) Sewage used for irrigation of forage crops should be given treatment insuring a consistent reduction in coliform bacteria of not less than 90 percent.

(2) Sewage used for irrigation of human food crops should be given treatment insuring a consistent reduction (a) in suspended solids of not less than 75 percent, (b) in 5-day 20°C. B.O.D. of not less than 75 percent, and (c) in coliform bacteria of not less than 98 percent unless discharged into a stream where the volume of dilution water,

available during the low flow periods during which irrigation diversions may occur, is at least 10 times greater than the anticipated maximum daily volume of sewage, in which case a bacterial reduction of 90 percent may be acceptable.

Provided, however, that where the time of passage from plant discharge to irrigation diversion is such as to permit the normal death rate of bacteria as evidenced by the die-away curve to provide equivalent bacterial reduction, the requirement of (1) and (2) above may be appropriately modified.

The protection of water rights must also be considered in determining pollution prevention measures needed. Pollution control and the doctrine of appropriated rights as applied in the States of Colorado, Nebraska, and Wyoming, are perfectly compatible. Sewage treatment is a measure of conservation which greatly increases the usefulness of water and thus in a sense actually increases its value. Whether or not treatment requirements can be reduced by increasing the amount of dilution water is a decision which must be made on the basis of economics and the availability of water. The benefits to be derived will determine the degree of treatment and the amount of water which can be allocated for sanitation purposes.

Waste treatment measures are usually tailored to the needs of a community following the engineering evaluation of local sanitary problems. Municipal treatment plants are usually of two general types, one of which removes settleable material from the sewage under quiescent flow conditions and the other removes additional polluting material by biological means. Within these categories numerous combinations or adaptations thereof can be used to meet variant conditions of waste from a community and requirements of the receiving stream. Industrial treatment processes vary widely, often within the same general type of industry. Changes in processes, by-products recovery, salvage, improved housekeeping, and comparable practices are often very effective measures of controlling industrial pollution. Control of industrial wastes may present an entirely different problem than that of municipal wastes, since the industrial wastes may contain toxic or otherwise objectionable substances not amenable to either sedimentation or biological treatment. However, the objective of the control program remains the same--protection of waters by reduction of objectionable substances to within tolerance levels compatible with water uses. The water pollution control programs in the South Platte Basin are based on these premises.

Sewage and waste treatment processes cannot be controlled precisely, but they can be regulated between rather well established limits. The effective removal of solids from domestic wastes by sedimentation is termed primary treatment and is generally considered to reduce Biochemical Oxygen Demand* from 25 to 40 percent. The removal of Biochemical Oxygen Demand by biological methods is termed secondary

*Biochemical Oxygen Demand is the quantity of oxygen utilized by microorganisms under aerobic conditions while feeding on and stabilizing organic materials under specified conditions of time and temperature.

treatment. A plant incorporating effective secondary treatment is generally considered capable of removing from 75 to 85 percent of the organic polluting material. Greater reduction, sometimes referred to as tertiary treatment, can be obtained by repetitive passages of wastes through the treatment processes or by increasing the number of combinations of treatment processes. Sewage and waste treatment methods thus defined apply only to organic materials that can be decomposed by biological action or those that may be removed by sedimentation. Inorganic wastes such as most acids, alkalies, and metallic ions, must be controlled by recovery, neutralization, storage, evaporation or other specialized processes.

The water pollution control agencies in the South Platte Basin have endorsed the following:

(1) Toxic substances including metallic ions, phenol compounds, oils, and acids must be virtually eliminated from streams. Such substances are inimical to aquatic life and if present in sufficient concentrations are hazardous to human life and to livestock.

(2) Removal of settleable and floating solids to prevent sludge banks, floating materials, and nuisance conditions are required as the minimum acceptable treatment. Property values, recreation, fishing, stock watering, and other water uses are thus provided a measure of protection.

(3) Treatment required beyond effective primary treatment is influenced by downstream water uses and by the amount of dilution water available during periods of low flow. Biological removal of dissolved organic materials and bacteria must be provided where necessary to: (a) maintain dissolved oxygen at levels necessary for balanced aquatic life; (b) maintain desirable water quality for domestic, industrial, or recreational uses; and (c) prevent nuisance and health hazards.

(4) For industrial wastes similar in nature to municipal wastes, treatment should be based on the same premises as that recommended for municipalities. For industrial wastes not similar to municipal wastes, treatment should be provided as necessary to prevent substantial deterioration of water quality in the receiving stream.

The future water pollution control program in the South Platte River Basin requires:

(1) Enactment of comprehensive pollution control legislation in Colorado and Nebraska.

(2) Construction of treatment plants where none now exist, and improvement of existing plants where they inadequately meet needs.

(3) Improved operation and maintenance of existing treatment works.

(4) Periodic surveillance of stream conditions to supplement sewage treatment plant inspections so that needs for improved treatment can be seen well in advance of actual necessity, thus enabling planning and construction to be carried forward with a minimum of delay.

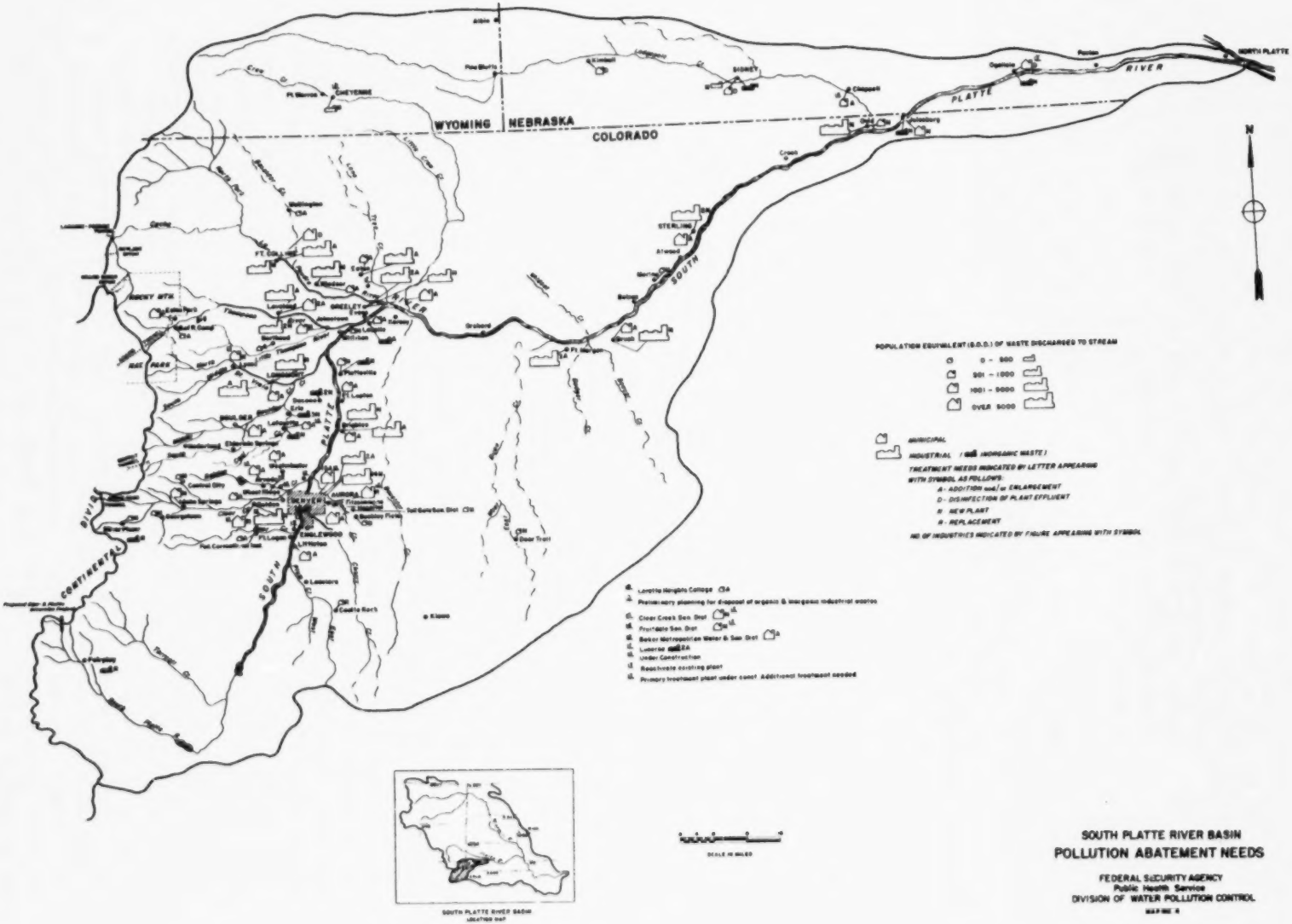
(5) Minimizing the adverse effects of mine wastes in streams through a program of adequate mine waste controls.

(6) Dissemination of information concerning the effects of pollution on public health, municipal and industrial water supply, fishing, irrigation, livestock watering, waterfowl production, recreation, and other water uses.

Action toward achievement of a comprehensive stream pollution control program in Colorado, Nebraska, and Wyoming, is under way by direction of the State health agencies. Progress will be largely determined by the ability of the agencies to secure the support of the citizens of the States who must provide adequate legislation, funds, and personnel for this purpose.

The cost of providing municipal sewage treatment has been estimated to range between $9 and $30 per year per family, depending upon the degree of treatment and the size of the community. In larger municipalities the costs tend to be less per capita. These quotations include construction, operation and maintenance. The expense of constructing the recommended improvements in the South Platte Basin is estimated at $10,500,000, of which $7,000,000 represents recommended municipal sewage works and $3,500,000 industrial waste treatment. These figures do not include construction, operation and maintenance of pump stations, trunk and outfall sewers.

Surveys of most of the sources of pollution in the South Platte Basin have been made by the State water pollution control agencies and reports containing the findings of these investigations, together with recommendations for correcting or improving conditions, have been provided municipal or industrial officials and other interested parties. The State water pollution control agencies have also cooperated with representatives of many industries and municipalities through conferences regarding specific problems of pollution, and have worked closely with engineers officially employed by municipalities and industries to study the pollution problems. Where consulting engineering studies are available they generally substantiate the treatment needs indicated in table 1 and Map 4. Municipal and industrial waste treatment needs are summarized in table 11. The status of municipal and industrial action on pollution abatement needs is given in table 12. Eight municipal plants are now under construction; 1 has final plans approved; 2 municipalities have prepared preliminary plans; and 38 are inactive. One industry is constructing a treatment plant; 3 have prepared preliminary plans; 1 is engaged in a study of its waste disposal problem; and 52 are inactive.



SOUTH PLATTE RIVER BASIN
POLLUTION ABATEMENT NEEDS

FEDERAL SECURITY AGENCY
Public Health Service
DIVISION OF WATER POLLUTION CONTROL

The value of supplemental flows from proposed reservoirs for alleviating stream pollution has been considered by the water pollution control agencies. It is of great importance that the reservoir regulatory programs provide for release of water, where indicated and when possible, to implement sewage and industrial waste treatment.

Table 11. South Platte River Basin - Needs for municipal[1] and industrial[2] waste treatment plants

	Municipal		Industrial
Needs	Number	Population served by facilities	Number[3]
New plants	15	19,430	39
Enlargement or additions to existing plants	27	590,040	15
Replace existing plants	2	17,740	2
No project required	14[a]	80,110[a]	24

[1]Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

[2]Industries having separate outlets discharging wastes directly to watercourse.

[3]Does not include 8 industries with incomplete data.

[a]Disinfection recommended for effluents of 5 existing secondary treatment plants and for 1 treatment plant which requires reactivation.

Table 12. South Platte River Basin - Current status of municipal[1] and industrial[2] action on pollution abatement needs

Status of project	Number of municipalities	Number of industries
Inactive	38	52
Preliminary plans	2	3
Final plans approved	1	0
Under construction	8	1

[1]Includes incorporated or unincorporated municipalities, other legal bodies as sanitary districts, counties, towns, significant institutions, resorts, recreational centers or other population centers.

[2]Industries having separate outlets discharging wastes directly to watercourse.

A resumé of the needs of municipalities, institutions, and industries necessary to prevent pollution of streams of the South Platte system is presented as follows:

Arvada, Colorado

Arvada treates wastes from its 2,400 residents with primary treatment works. The plant effluent is discharged into Ralston Creek one mile above the junction with Clear Creek. Immediate and complete use of the normal water supply of the stream during summer for irrigation requires a high degree of treatment to protect irrigation uses. Therefore, secondary treatment and effective chlorination are recommended.

Aurora, Colorado

This suburb of Denver has its own municipal sewer system and primary treatment works. Approximately 17,000 people are served. The effluent from the treatment plant is discharged into Sand Creek. It is recommended that additional plant capacity, plus secondary treatment and effective chlorination be added to the present facilities. A new secondary treatment plant is under construction and is expected to be in operation June, 1953.

Baker Metropolitan Water and Sanitation District, Colorado

The sewerage system of Baker Metropolitan Water and Sanitation District, placed in operation late in 1952, serves a population of 2,000. The plant provides primary treatment and discharges to Clear Creek. As the population grows, additions will be made to the sewage treatment plant. This program of sewage treatment should prove satisfactory; however, secondary treatment and effective chlorination should be provided.

Berthoud, Colorado

This municipality of 1,000 inhabitants is located on the Little Thompson River which flows into the Big Thompson just above Milliken. Berthoud provides secondary treatment effecting a B.O.D. reduction of about 60 percent. There are many irrigation diversions below Berthoud indicating need for a high degree of treatment. It is recommended that secondary sedimentation and adequate chlorination be added to existing facilities. The Colorado-Big Thompson project is expected to increase stream flow in the Little Thompson River at Berthoud about 10 second-feet above present flows during the summer months and to slightly increase winter flows.

Boulder, Colorado

The City of Boulder, including the University of Colorado, provides primary treatment to wastes having a population equivalent of 21,400. The plant effluent is discharged into Boulder Creek, a tributary of St. Vrain Creek. It is estimated that about one-third of the B.O.D. is removed by treatment. Bacteriological studies of Boulder Creek during 1950 indicated that in the period May to September the

number of coliform organisms was high. It is probable that proposed transmountain diversions will increase the average flow in Boulder Creek during the summer months, but water would also be rediverted from the stream above the confluence with the South Boulder Creek. It is therefore recommended that secondary treatment and effective chlorination be provided. Final plans and specifications for a new plant have been approved.

Brighton, Colorado

Brighton discharges treated wastes into the South Platte River about 16 miles below Denver. An estimated 4,500 people are tributary to Brighton sewers and secondary treatment is provided. As the South Platte below Brighton is used for irrigation it is imperative that a high degree of treatment be maintained. It is recommended that secondary settling and effective chlorination be added to treatment facilities now in operation. According to the Bureau of Reclamation's operational plan, flow in the South Platte River will not be materially changed below Brighton because the contemplated importation of water will be diverted at or above Brighton.

Wastes from the Kuner-Empson cannery and the Great Western Sugar Company refinery enter the South Platte River in the immediate vicinity of Brighton, about 15 miles below Denver. The cannery has a population equivalent of about 7,500 and operates from June through August. The Great Western Sugar Company contributes a population equivalent of 180,000 during the period October through December. The cannery provides no treatment and the sugar company has maintained some lagoons, the effects of which are negligible. Both enterprises should provide adequate treatment or other appropriate control measures for their wastes.

Brush, Colorado

This city of approximately 2,500 provides primary treatment in an Imhoff tank. The treated wastes are discharged into the South Platte River. Here roughly 10 miles upstream from Brush a higher degree of treatment is necessary to produce a water quality compatible with irrigation uses. Brush is located below the proposed Narrows Reservoir from which it may be possible to augment present low flows; however, it is unlikely that the volume of water available for dilution of sewage will be sufficient to allow a reduction in treatment requirements. It is recommended that secondary treatment and adequate chlorination be provided.

The Great Western Sugar Company plant at Brush, Colorado, contributes without treatment an estimated 250,000 population equivalents to the South Platte River. Adequate treatment or equivalent control measures should be provided.

Buckley Naval Air Station

The air field has secondary treatment facilities. The effluent flows to Sand Creek which passes through Denver to its junction with the

South Platte River. It is recommended that the plant be provided with better operation and that its effluent be adequately chlorinated.

Bureau of Reclamation Camp at Estes Park

The Bureau of Reclamation Camp has a population of about 500. Sewage is provided secondary treatment which removes about 60 percent of the B.O.D. prior to discharge into Estes Park Lake. It is recommended that plant efficiency be increased by the addition of secondary sedimentation and effective chlorination. An alternate solution is a sewer connection to the sewage treatment plant at Estes Park.

Castle Rock, Colorado

This municipality of 740 inhabitants has a municipal sewer system and treatment facilities which consist of septic tanks and lagoons. It is reported that the effluent from the treatment facilities does not reach a waterway. The city is located in the upper reaches of Plum Creek, a tributary which joins the South Platte River just above Denver. No problem of stream pollution is evident at Castle Rock; however, due to deterioration of the present plant, replacement of the existing plant with secondary treatment should be undertaken to prevent possible local nuisance conditions.

Central City, Colorado

Central City discharges sewage without treatment directly into the North Fork of Clear Creek. Because of extensive use of this popular resort area, secondary treatment is recommended.

Clear Creek Sanitation District, Colorado

Clear Creek Sanitation District has a primary treatment plant under construction designed to serve a population of 5,000. The effluent will be discharged to Clear Creek which is used for irrigation. Secondary treatment and effective chlorination are recommended.

Deer Trail, Colorado

Deer Trail is located on Bijou Creek which joins the Platte River just above Fort Morgan, Colorado. Municipal sewage from 390 inhabitants is discharged untreated into Bijou Creek. Secondary treatment and adequate chlorination are recommended.

Denver, Colorado

The major municipal pollution problem in the South Platte Basin arises from the discharge of sewage and industrial wastes from the City of Denver. Denver's sewage output to the South Platte River may constitute as much as 85 percent of the stream flow below the city during the months when river flows are at a minimum. Denver sewage is provided intermediate treatment and postchlorination. Approximately 84 M.G.D. domestic sewage and industrial wastes are treated at Denver's north side plant which consists of: a screen

house where coarse solids are screened out and removed; a grit chamber where grit and similar detritus settle out and are removed; aeration tanks to improve flocculation and settling; sedimentation tanks; separate sludge digestion tanks and sludge drying beds. The plant effluent is chlorinated prior to discharge into the South Platte River. About 45 percent of the organic polluting material is removed in the treatment works.

Rapid growth of metropolitan Denver necessitates a pollution abatement program of effective waste treatment. Because of downstream water use it is necessary to provide effective secondary treatment and chlorination. An exceptionally high degree of treatment is recommended. Complexities of metropolitan growth may require the consideration of an over-all plan of sewage and waste disposal for Denver and environs.

Approximately 14,000 population equivalents of wastes from industries located outside the corporate limits and not connected to the Denver sewage system, are discharged to the South Platte River system without treatment, thus adding to a problem already great. Included in this figure are six small meat plants which discharge wastes equivalent to sewage from 12,000 people.

In addition, three petroleum refineries discharge industrial wastes estimated to have population equivalents of 5,000 into Sand Creek, a tributary of the South Platte River about two miles below the Denver treatment works. Another oil refinery with 4,800 population equivalents and a paper mill with 7,800 release industrial wastes to the Burlington-O'Brian Ditch. Organic wastes should be adequately treated or appropriately controlled before being discharged to the South Platte and tributary streams in the area. Toxic elements should not be released to watercourses.

Eaton, Colorado

Eaton discharges its wastes into a small creek which joins the Cache la Poudre River above Greeley. The city's 1,300 residents are served by a septic tank and sand filters. The latter unit is now bypassed and only a negligible portion of the polluting material is removed by existing treatment. The creek at Eaton is normally dry, and effective treatment is needed to prevent local nuisances. It is recommended that Eaton replace its present facilities with modern secondary treatment and effective chlorination.

The Great Western Sugar Company's plant at Eaton is located on a small creek tributary to the Cache la Poudre. The tributary creek is very often dry. The Eaton sugar refinery contributes an estimated 140,000 population equivalents of waste into the creek about 8 miles above its junction with the Cache la Poudre. Adequate waste treatment or other appropriate control measures is recommended.

Englewood, Colorado

Englewood discharges wastes from 16,000 people to Denver's municipal sewage works under a contractual agreement. Englewood is constructing a secondary treatment plant which includes effective chlorination.

Estes Park, Colorado

Estes Park is a summer resort whose winter residential population of about 850 may increase to as many as 6,000 in the summer. The city provides secondary treatment for its sewage, which is discharged into the Big Thompson River at Estes Park Lake. The great importance of the Estes Park area as a recreational center makes it imperative that surface water quality be maintained in excellent condition. It is recommended that secondary sedimentation and improved chlorination practices be added to the present sewage treatment works.

Federal Correctional Institution, Colorado

This institution, located a short distance above the City of Denver, has treatment facilities consisting of an Imhoff tank and trickling filter. The effluent is discharged into Bear Creek. It is recommended that facilities for secondary settling and effective chlorination be provided.

Fort Collins, Colorado

Fort Collins is located on the Cache la Poudre River about 38 miles above its mouth. City sewers service about 15,000 inhabitants and industrial wastes with a population equivalent of 4,230. The sewage treatment plant, consisting of primary sedimentation, trickling filters with recirculation, secondary settling and separate sludge digestion, removes about 85 percent of the B.O.D. It is recommended that effective chlorination be provided.

The Dreher Pickle Company discharges untreated industrial wastes estimated at 2,600 population equivalents to the Cache la Poudre River. Adequate treatment or other control measures should be provided.

The Great Western Sugar Company discharges an estimated 710,000 population equivalents during the sugar beet campaign. Flows in the Cache la Poudre are inadequate to cope with this tremendous amount of pollution. Provision should be made for adequate treatment or other appropriate waste control measures.

Fort Lupton, Colorado

About 2,200 people are served by the sewage works. Primary treated sewage is discharged into the South Platte River about 14 miles below Brighton. Industrial wastes in the City of Fort Lupton increase the municipal population equivalents to 5,400; treatment reduces this approximately 30 percent. The widespread use of waters in this section of the South Platte for irrigating truck crops makes it necessary at all times to have effective treatment and to control pathogenic contamination. It is recommended that Fort Lupton install secondary treatment units and provide adequate chlorination.

Fort Morgan, Colorado

In the vicinity of Fort Morgan, the Great Western Sugar Company operates a beet sugar plant which, during the campaign season, contributes an estimated 450,000 population equivalents to the South Platte River. Flows in the South Platte are not sufficient to assimilate these wastes and nuisance conditions result. Adequate treatment or other appropriate waste control measures should be installed at the refinery.

Fruitdale Sanitation District, Metropolitan Denver, Colorado

A primary treatment plant designed for a population of 5,000 is under construction. Discharge will be to Clear Creek. Secondary treatment and adequate chlorination are recommended.

Georgetown, Colorado

The sewage of the 120 residents of Georgetown is discharged to Clear Creek without treatment. The City of Georgetown is located a few miles above White Reservoir. Since recreational activity and tourist trade are the principal sources of income for the residents of this area, it is imperative that the health of those who enjoy the facilities be protected and that such important adjuncts as waterways, lakes, and reservoirs be kept free of the unsightliness of sewage pollution. It is recommended that secondary sewage treatment and effective chlorination be provided.

Golden, Colorado

The 6,200 residents of Golden contribute untreated sewage to Clear Creek. Golden, which includes the Colorado School of Mines, is the largest community in the Clear Creek watershed and lies in the plains area where Clear Creek emerges from the mountains. Many industries located in and below the city are not connected to the sewer system. Irrigation diversions from Clear Creek immediately below Golden dictate a definite need for sewage treatment to protect this use. It is recommended that secondary treatment and effective chlorination be provided. Recently, the Coors Brewery began construction of a sewage treatment plant to serve the brewery, the City of Golden, and the malted milk plant.

Greeley, Colorado

This city of 21,000 people is situated on the Cache la Poudre River about four and one-half miles above its confluence with the South Platte. Municipal sewage and organic industrial wastes with a population equivalent of 5,160 are treated in a chemical precipitation plant. Bacteriological observations of the Cache la Poudre River showed that bacteria densities increased greatly below the sewage works. Flow in the Cache la Poudre at Greeley is very low during the summer-winter period.

Diversion of large quantities of irrigation water below Greeley indicates that a much higher degree of treatment is needed. It is

recommended that capacity of the primary sedimentation facilities be increased and that secondary treatment plus effective chlorination be added.

A number of industries located within a short distance of the City of Greeley also discharge a heavy industrial waste load. The Greeley Rendering Works emits an estimated 1,700 population equivalents without treatment to the Cache la Poudre; the Associated Seed Growers, Inc., untreated wastes equivalent to 2,300; and the Great Western Sugar Company Refinery, 180,000 population equivalents. The summation of all these wastes far exceeds that from the City of Greeley. These wastes are amenable to biological treatment, process changes, or other conservation methods which would materially reduce the amount of pollution going into the stream. The industries, with the exception of those operated by the Great Western Sugar Company, are year-round operations. It is recommended that adequate secondary treatment or equivalent waste control measures be provided.

Idaho Springs, Colorado

Idaho Springs discharges untreated wastes from its 1,800 residents into Clear Creek. The pollution problem below Idaho Falls is very similar to those at Silver Plume and Georgetown. Secondary treatment, plus effective chlorination, is recommended.

A quantity of inorganic wastes from mining and milling operations reaches upper Clear Creek and presents a pollution problem difficult to evaluate. Among the companies which produce these inorganic wastes are: Old Ore Processing Mill, the A.S.& R. Mill, the Lombard Mill, Black Eagle Mill, the Bortimer Mill, Silver Spruce Mill, Argo Mill, and the Dixie Mill. Adequate treatment, by-products recovery, conservation, and/or other methods, should be employed to reduce the amount of waste to a tolerable degree.

A number of mining industries, including the Ozark-Mahoney Milling Company near Jamestown, and the Wolftongue Milling Company near Nederland, contribute inorganic wastes to headwater streams of St. Vrain Creek. Appropriate control of these wastes is indicated.

Johnstown, Colorado

Sewage from Johnstown's 900 inhabitants, plus wastes from a condensed milk plant having a population equivalent of about 450, are discharged untreated into the Little Thompson River 2 miles above its junction with the Big Thompson and only 3 miles above the City of Milliken. Irrigation diversions take off immediately below Johnstown. Bacteriological tests indicate that coliform organisms are very numerous in both the Little Thompson and Big Thompson Rivers. Present flows at Johnstown in the Little Thompson River would be increased on an average about 10 second-feet in the summer months and 2 second-feet in the winter period by the Colorado-Big Thompson project. Sewage treatment incorporating secondary facilities and effective chlorination should be provided.

At Johnstown, the Great Western Sugar Company produces sugar from Steffen house wastes obtained from other plants. The pollutional load discharged is negligible.

Julesburg, Colorado

Sewage from the city's 1,800 people is discharged untreated into the South Platte River. Water is diverted for irrigation purposes a short distance below the city. It is recommended that secondary treatment plus effective chlorination be provided.

Lafayette, Colorado

This community of 1,250 inhabitants is located on Coal Creek, a tributary of Boulder Creek. Sewage is given primary treatment which reduces the Biochemical Oxygen Demand by about 30 percent prior to discharge into the creek. Irrigation water is diverted immediately below Lafayette; therefore, secondary facilities and effective chlorination should be instituted.

La Salle, Colorado

La Salle, located about 25 miles below Platteville, contributes wastes equivalent to that of about 700 people to the South Platte River. A septic tank provides a minor degree of treatment. Here, as at other cities previously mentioned, a high degree of treatment is required to prevent undue contamination of irrigation waters. It is recommended that secondary treatment, together with effective chlorination, be provided.

Littleton, Colorado

This municipality discharges its treated sewage into the South Platte River about 15 miles above the City of Denver. Wastes are given treatment consisting of primary settling, separate sludge digestion, and trickling filters. Operational difficulties have been due to oil from industrial plants, insufficient capacity of the primary facilities, and ponding of the trickling filter which has resulted from faulty grading of gravel. Approximately 50 percent of the pollutional material is removed prior to its discharge into the river. The proximity of Littleton to the residential part of Denver through which the South Platte River flows makes it imperative, from a public health point of view, that a much higher degree of treatment be provided. Additional primary settling capacity, secondary settling, and chlorination, are recommended.

Longmont, Colorado

This city of 8,000 people, on the upper reaches of St. Vrain Creek, provides treatment consisting of primary settling, trickling filters, and separate sludge digestion. It is estimated that treatment removes approximately 50 percent of the B.O.D. St. Vrain is a very rapidly flowing creek and recovery from pollution discharged at Longmont is rapid. The first diversion below Longmont is about 14 miles from the point of sewage discharge. Coliform organisms, however, are still in excess of safe limits, and remedial action is necessary to protect irrigation uses. It is recommended that secondary settling facilities be

added to existing treatment works and the effluent be effectively chlorinated.

The Kuner-Empson Company which operates a cannery near Longmont, Colorado, has an estimated population equivalent of 18,000 during its period of operation, normally June through August. Wastes are discharged, untreated, into St. Vrain Creek. The Great Western Sugar Refining Plant at Longmont contributes an estimated 700,000 population equivalents of wastes to St. Vrain Creek. This tremendous pollutional load, far in excess of the stream's assimilation capacity, is discharged October through December. Adequate treatment of industrial wastes, or other appropriate control measures, are recommended.

Loretto Heights College

Sewage from the college is treated in a primary settling tank and discharged to Bear Creek. It is recommended that secondary treatment plus adequate chlorination be provided at the college to insure proper protection of the waters of Bear Creek and the South Platte River against pathogenic bacterial contamination.

Loveland, Colorado

Loveland is located on the Big Thompson River about 32 miles downstream from Estes Park. Municipal sewers serve about 8,000 people and discharge into two secondary treatment plants which remove about 50 percent of the B.O.D. The extensive diversion of water below Loveland for irrigation purposes dictates need for a high degree of treatment. The old plant, which treats the wastes of 2,000 people, requires improved operation and the installation of secondary sedimentation and postchlorination units. The newer plant which normally treats wastes from a population of 6,000 receives an additional 3,750 population equivalents from a local industry during the canning season and needs effective effluent chlorination.

The Cherry Products Company, and the Kuner-Empson Company operate canneries in the vicinity of Loveland, Colorado. These plants discharge wastes into the Big Thompson River or the small tributary streams which join the Big Thompson near Loveland. The Cherry Products Company and the Kuner-Empson Company each contribute an estimated 2,500 population equivalents. Neither of the plants has treatment facilities and it is recommended that secondary treatment or equivalent control measures be provided.

The Great Western Sugar Company at Loveland discharges, without treatment, wastes estimated at 640,000 population equivalents into the Big Thompson River. The company is experimenting with treatment facilities but has not yet advanced to plant-sized operation. Adequate treatment or equivalent waste control measures should be provided.

Lyons, Colorado

Lyons, situated on North St. Vrain Creek above Longmont discharges wastes from an estimated 1,430 people. Longmont's water

supply intake is situated below Lyons. In addition, downstream water uses include irrigation. Protection of water uses indicates the need for a high degree of secondary treatment and efficient effluent chlorination.

Merino, Colorado

This village of 300 persons discharges untreated sewage into the South Platte River. Merino is located about 7 miles below Brush and about 13 miles above Sterling. Secondary treatment plus effective chlorination should be provided.

Milliken, Colorado

Sewered wastes from Milliken's 500 inhabitants are discharged untreated into the Big Thompson River. Diversions for irrigation immediately below the city indicate the need for a high degree of treatment. It is recommended that secondary treatment and adequate chlorination be installed.

Ovid, Colorado

This municipality of 700 people discharges its sewage untreated into Lodgepole Creek about 0.2 of a mile above the creek's junction with the South Platte River. It is recommended that secondary treatment plus effective chlorination be installed.

At Ovid, Colorado, the Great Western Sugar Company's plant contributes an estimated 290,000 population equivalents of waste into Lodgepole Creek about half a mile above its confluence with the South Platte River. The waste is untreated and produces severe pollutional conditions in both the tributary and main stream. Carry-over of wastes into Nebraska poses an interstate problem and appropriate action should be taken to reduce this pollutional load.

Platteville, Colorado

Platteville is located approximately 8 miles below Fort Lupton and discharges untreated wastes into the South Platte River. About 700 people are served by city sewers. Numerous diversions from the South Platte immediately below Platteville indicate that control of pathogenic contamination is necessary to maintain irrigation water quality. Secondary treatment and effective chlorination are recommended for Platteville.

Prospect Valley District, Colorado

Prospect Valley District is in the process of being organized as a water and sanitation district to serve approximately 500 existing housing units. The treatment plant will consist of primary clarification and separate sludge digestion. The effluent is to be discharged into Clear Creek and will be used for irrigation. Secondary treatment and adequate chlorination are recommended.

Silver Plume, Colorado

This small city of 140 inhabitants discharges its wastes directly into Clear Creek. Silver Plume is located high up in the headwaters section of the creek where the streams and scenery have very high values for recreational purposes. It is important that these values are not destoyed by pollution emanating from cities and towns located on Clear Creek. Silver Plume is approximately three miles above the next municipality and adequate protection must be given the stream as it flows through the downstream community. It is recommended that secondary treatment and effective chlorination be provided.

South Englewood Sanitation District, Colorado

Wastes from South Englewood Sanitation District will be discharged into the sewage works of the City of Englewood which is currently building secondary treatment facilities. Plans include adequate chlorination of the plant effluent.

Sterling, Colorado

At the present time sewage from Sterling is given primary treatment which reduces the B.O.D. approximately 25 percent prior to discharge into the South Platte. Wastes contributed to the sewer system are estimated to have a population equivalent of about 7,500. Sterling is a rapidly growing community situated at the head of a large irrigated area. In order to protect irrigation waters from bacterial contamination it is recommended that secondary facilities and effective chlorination be provided.

The Sterling Rendering Works and the Great Western Sugar Company discharge wastes into the South Platte River in this reach. The rendering company provides no treatment. It is recommended that secondary treatment be provided. The sugar company should provide adequate treatment or other appropriate waste control measures.

Wellington, Colorado

Wellington is located on Box Elder Creek which joins the Cache la Poudre River a short distance below Fort Collins. The sewage from 540 inhabitants is treated in an Imhoff tank prior to discharge into the creek. The stream is a dry run during much of the year. It is recommended that secondary treatment facilities and effective chlorination be added to the existing plant to protect against local nuisance conditions.

Westminster, Colorado

The municipal sewage from Westminster is given secondary treatment prior to discharge into Clear Creek about three and one-half miles above the junction of the South Platte River. Absence of secondary settling reduces the over-all efficiency of the plant and permits quantities of polluting materials to reach the creek. Diversion of irrigation water below the outlet of the treatment works makes it

necessary to maintain a high degree of sewage treatment. It is recommended that secondary settling be provided and the effluent be adequately chlorinated.

Wheatridge Sanitation District

In the metropolitan Denver area, Wheatridge Sanitation District sewers serve approximately 2,300 people. Its secondary treatment works consist of primary clarification, trickling filter and separate sludge digestion units. Plant effluent is discharged to Clear Creek. For protection of downstream water uses secondary settling and effective chlorination should be provided.

Windsor, Colorado

Windsor is located about 17 miles below Fort Collins. Municipal sewage from 2,000 people is treated in a modified Imhoff tank followed by trickling filters and then discharged to the Cache la Poudre River. An estimated 60 percent of the B.O.D. is removed. Numerous diversions below Windsor indicate the necessity for a high degree of treatment. It is recommended that the present treatment works be supplemented by secondary sedimentation and effective chlorination.

The Great Western Sugar Company plant at Windsor is located about 10 miles downstream from the Fort Collins installation and contributes about 210,000 population equivalents. Treatment or equivalent control should be provided to reduce the strength of these wastes.

Chappell, Nebraska

Chappell is located on Lodgepole Creek about 10 miles above its confluence with the South Platte River. The sewage is given primary treatment in an Imhoff tank and discharged into Lodgepole Creek. Sand filters were provided but have not been used in recent years. The municipality is presently constructing a new plant which consists of primary settling, biological treatment, secondary sedimentation, and heated digestion with additional sludge storage. Operation of the new plant may be initiated during the spring of 1953.

Kimball, Nebraska

This city of 2,000 provides treatment consisting of an Imhoff tank, trickling filters, secondary settling and separate sludge digestion. Final discharge is to Lodgepole Creek. The presence of irrigation diversions immediately below Kimball indicates the need for a high degree of treatment during irrigation seasons. It is recommended that plant operation be improved and adequate chlorination be provided.

Ogallala, Nebraska

This city of approximately 2,000 inhabitants is contributing untreated sewage directly to the South Platte River. The city has a sewage treatment plant capable of a high degree of treatment which

consists of primary settling, activated sludge, secondary settling, and separate sludge digestion. No use is being made of the existing facility. Since a very high degree of treatment is desirable to protect irrigation waters it is recommended that Ogallala reactivate the facilities and effectively chlorinate the plant's effluent.

North Platte, Nebraska

North Platte lies between the North and South Platte Rivers and discharges a portion of its sewage and industrial wastes into each river without treatment. At the present time about one-third of North Platte's domestic wastes enter the South Platte. Zero summer flows in the South Platte may be expected and zero flows have been recorded as winter minima. Effective secondary treatment including adequate chlorination should be provided all wastes emanating from the city.

Sidney, Nebraska

This city of 5,000 inhabitants has primary sedimentation, trickling filters, secondary settling and separate sludge digestion for treating municipal wastes. The treatment plant effluent is discharged into Lodgepole Creek. Numerous diversions immediately below Sidney indicate that a high degree of treatment is needed and it is recommended that effective chlorination be provided.

Cheyenne, Wyoming

Two industries are located at Cheyenne, Wyoming. One, a small meat packing house, contributes an estimated 320 population equivalents and should provide adequate treatment or connect to the municipal system. The second, the Union Pacific Railroad Shops, has retained an engineer to study its waste disposal problem. These wastes, combined with low flows in Crow Creek, presently produce very unsatisfactory conditions.